Technical Report EL-94-9
August 1994

US Army Corps
of Engineers
Waterways Experiment
Station

# Calcasieu River Sediment Removal Study

*by Roy Wade*



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Prepared for U.S. Army Engineer District, New Orleans

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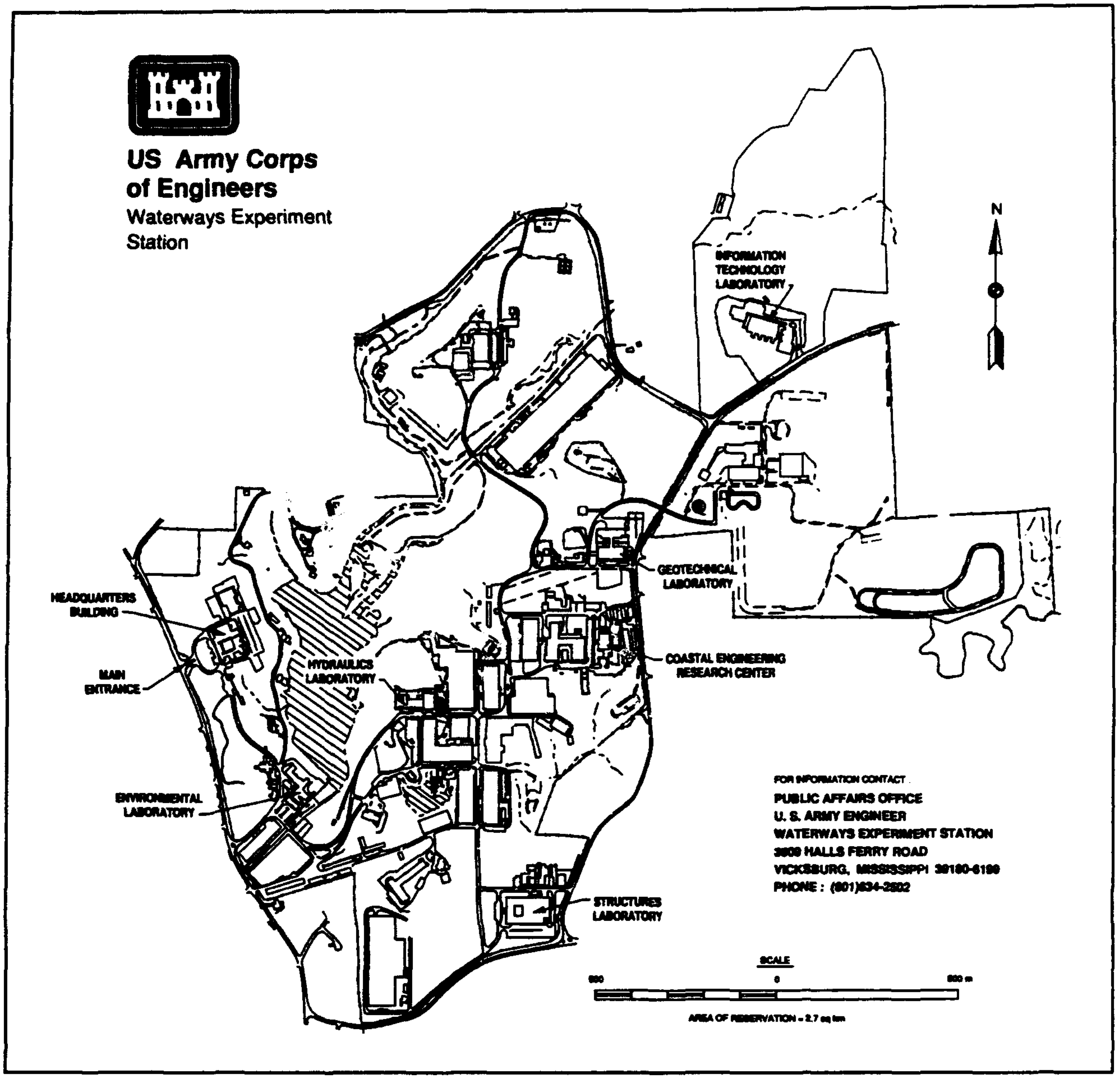


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# Preface

The study herein was conducted as a part of the Calcasieu River Sediment Removal Study. This report was prepared at the U.S. Army Engineer Waterways Experiment Station (WES) in cooperation with the U.S. Army Engineer District, New Orleans. Project manager for the New Orleans District was Ms. Linda Glenboski-Mathies. Project manager for WES was Mr. Roy Wade.

The settling and modified elutriate studies were conducted between May 1993 and October 1993 in the WES Environmental Laboratory (EL). This report was written by Mr. Wade, Environmental Restoration Branch (ERB), Environmental Engineering Division (EED), EL, WES. Laboratory support was provided by Messrs. Delmon Cotton and Jamie Yearwood.

The report was prepared under the direct supervision of Mr. Norman R. Francingues, Jr., Chief, ERB, and under the general supervision of Dr. Raymond L. Montgomery, Chief, EED, and Dr. John W. Keeley, Director, EL.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

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# Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

| Multiply | By | To Obtain |
|---|---|---|
| acres | 4,046.873 | square meters |
| acre-feet | 1,233.489 | cubic meters |
| cubic feet per second | 0.0283165 | cubic meters per second |
| cubic yards | 0.7645549 | cubic meters |
| Fahrenheit degrees | 5/9 | Celsius degrees or kelvins[1] |
| feet | 0.3048 | meters |
| gallons (U.S. liquid) | 3.785412 | liters |
| inches | 2.54 | centimeters |
| miles (U.S. statute) | 1.609347 | kilometers |
| pounds (mass) | 0.4535924 | kilograms |
| pounds (mass) per cubic foot | 16.01846 | kilograms per cubic meter |
| square feet | 0.09290304 | square meters |
| square inches | 6.4516 | square centimeters |
| square miles | 2.589998 | square kilometers |
| tons (2,000 pounds, mass) | 907.1847 | kilograms |
| yards | 0.9144 | meters |

[1] To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain kelvin (K) readings, use the following formula: $K = (5/9)(F - 32) + 273.15$.

# 1 Introduction

## Background

Dredged material from the maintenance of miles 22 to 36 of the Calcasieu River and Pass, Louisiana, is placed in upland confined disposal facilities (CDFs) adjacent to the channel. The dredged material is placed into the CDFs by hydraulic dredging. Traditionally, the U.S. Army Engineer District, New Orleans, provides the dredging contractor plans with selected CDFs. The dredging contractor then prepares a dredging and disposal plan in which the contractor identifies the CDF to be used, requirements for dike upgrading, type of dredging equipment, etc. The contractor's plan is then reviewed by the New Orleans District.

Monitoring data collected during the 1988-1989 maintenance event indicated that the CDFs may not have been properly managed for maximum efficiency in settling, retention of suspended solids, and associated contaminants. Settling tests and modified elutriate tests are warranted to obtain data for characterizing sediment properties, to evaluate the contractor dredging plan, and to develop appropriate monitoring programs to ensure compliance with applicable water quality standards.

## Organization of Report

This report is presented in three chapters. The introduction and background information on the Calcasieu River are discussed in Chapter 1. Chapter 2 discusses methodologies and results of settling tests, modified elutriate tests, and turbidity measurements. Finally, conclusions and recommendations are presented in Chapter 3. Appendix A includes detailed test results.

## Purpose

The purpose of this report is to document and present the results of the column settling and modified elutriate tests performed as part of the sediment removal study and to apply the results to conceptual design of a CDF. The correlation of turbidity to total suspended solids (TSS) will be evaluated.

## Testing Objectives

The objective of the settling tests was to predict the settling behavior of Calcasieu River sediment when hydraulically dredged and placed in a CDF. The objective of the modified elutriate test was to predict the quality of the effluent by accounting for the dissolved concentrations of contaminants and the solid contaminant fraction associated with the TSS released. The objective of the turbidity and TSS correlation was to develop a curve that a contractor and/or inspector can use to quickly estimate TSS by measuring turbidity. Turbidity is a much more easily measured parameter than TSS because turbidity is measured with an off-the-shelf type meter, while TSS has to measured in a laboratory using ovens, analytical balances, etc.

Prior to running the settling and modified elutriate tests, homogenized sediment samples were collected and analyzed for organic and inorganic constituents. Historical data have not shown evidence of any significant levels of contamination in the sediments requiring removal at the Calcasieu River. However, it is not uncommon for dredged material resulting from the sedimentation in rivers near industrialized areas to contain contaminants. The outfalls from factories and city wastewater treatment systems may result in contaminant levels in the sediment that may be high enough to cause concern during dredging and disposal operations.

## Scope Of Work

The scope of work included performing laboratory column settling tests on three Calcasieu River sediments and estimating for each sediment the volume requirements for storage in the CDF and the surface area requirements for suspended solids removal effectiveness for the CDFs. An initial screening for contamination was performed to determine if there was a reason to believe that the sediment contained any contaminant at a significant concentration and to identify the contaminants that should be analyzed in the modified elutriate test. The modified elutriate test procedure was run to define the dissolved concentration and the fraction of the particle-associated contaminant in the TSS under quiescent settling conditions for each contaminant of concern. This procedure also accounts for geochemical changes occurring in the disposal area during active disposal operations.

# 2 Settling and Modified Elutriate Tests

## Background

Sediment removal is required to restore a navigable waterway in the Calcasieu River. One alternative being considered for the Calcasieu River is hydraulic dredging, with temporary or permanent dredged material disposal in an upland CDF. The conceptual design of the facility requires an evaluation of the settling behavior and properties of the dredged material in order to estimate the storage requirements and to promote good settling within the CDF. Efficient solids removal benefits CDF effluent quality by reducing possible particulate-associated contaminants along with lower suspended solids concentrations. Settling test procedures (Montgomery 1978; Palermo, Montgomery, and Poindexter 1978; Palermo and Thackston 1988) were used to predict the concentration of suspended solids in the effluent for given operational conditions at the Calcasieu River site. Modified elutriate tests (Thackston and Palermo 1990; Palermo 1984) were used to predict both the dissolved concentrations of contaminants in milligrams per liter and particle-associated contaminant fractions of the suspended solids in milligrams per kilogram of suspended solids under quiescent settling conditions. Using results from both the column settling test and the modified elutriate test, the total concentration of contaminants in the effluent was predicted. Using the column settling test results, the storage capacity of a CDF was determined based on compression settling data.

## Description of a Typical CDF

A CDF is a diked enclosure used to retain dredged material placed in the site. The CDF must be designed to provide adequate storage capacity for the settled sediments and efficient sedimentation to minimize the discharge of suspended solids (Montgomery, Thackston, and Parker 1983). Figure 1 shows an active CDF where the dredged material undergoes sedimentation, resulting in a "thickened" deposit of settled material overlain by the clarified supernatant. The supernatant waters are normally discharged from the site as effluent, which may contain dissolved and/or particulate-associated contaminants.

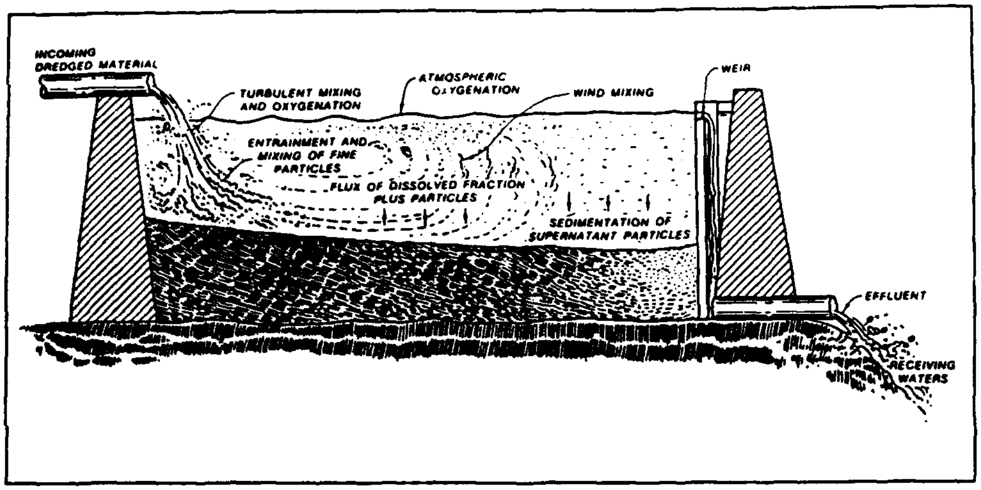


Figure 1. Schematic of an active CDF

Figure 1 also shows several factors influencing the concentration of suspended particles and contaminants present in supernatant waters. As dredged material slurry enters the ponded water, finer particles remain suspended in the water column at the point of entry because of turbulence and mixing. The suspended particles are partially removed from the water column by gravity settling. Some of the settled particles may reenter the water column because of the upward flow of water through the slurry mass during thickening and may reenter the water column by wind and/or surface wave action. If supernatant water is released during active phases of disposal, all solids cannot be retained. Therefore, dissolved and particulate-associated contaminants may be transported with the particles in the effluent to the receiving water outside the containment area.

# Experimental Procedures

## General

This part of the report describes laboratory testing conducted to predict solids storage capacity and effluent quality of the proposed CDF. Samples of sediment and water were collected and used to conduct the column settling and modified elutriate tests. Results from both of these tests were used to predict the total concentration of contaminants that may be present in the effluent. A flowchart illustrating the effluent quality prediction technique is shown in Figure 2.

## Sample collection

Sediment samples and site water from three reaches along the Calcasieu River (miles 23 to 36 at half-mile increments), Bayou D'Inde, and Clooney

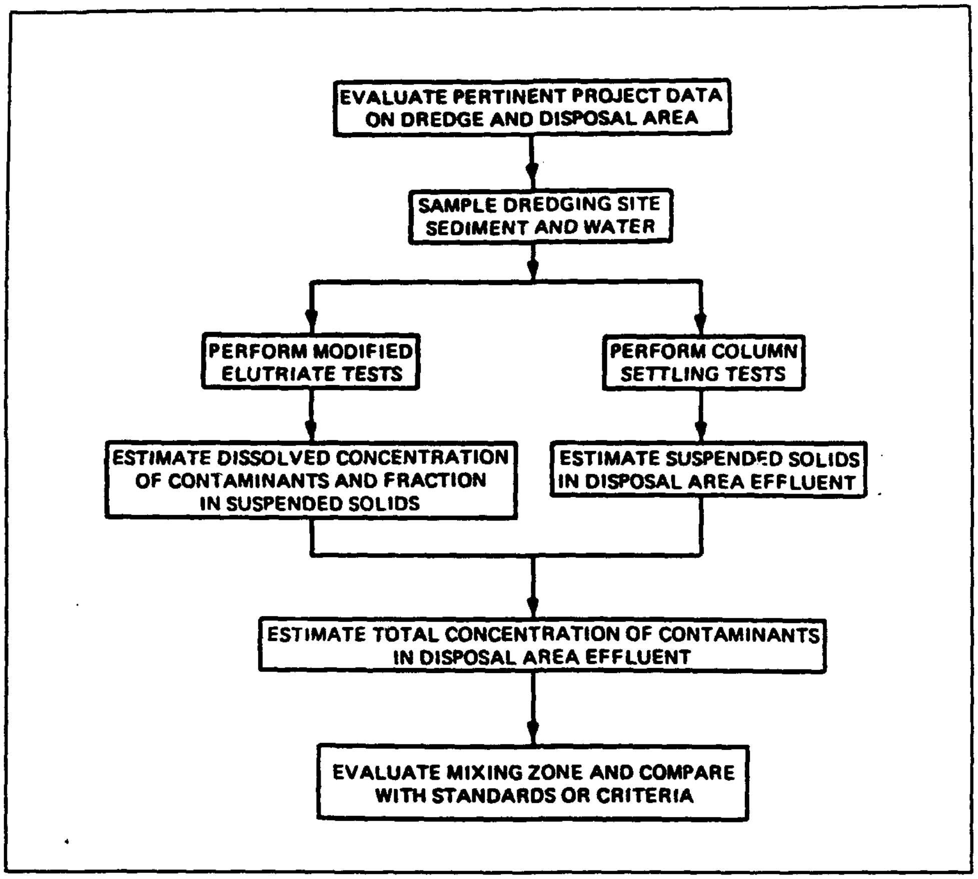


Figure 2. Steps for predicting effluent water quality (Palermo 1984)

Island Loop were collected during April 1993 by the New Orleans District. The individual sediment sampling stations chosen for the three reaches are shown in Table 1. The sediments and site water were delivered to the U.S. Army Engineer Waterways Experiment Station (WES) in 1-gal[1] jars. The Environmental Laboratory (EL), WES, composited and homogenized the sediment samples in three 55-gal drums. The sample was homogenized with a 3-hp Lightnin mixer for 1 hr. Total solids were run in triplicates to ensure a homogenized sample (Table 2). The sediment samples with similar physical characteristics, i.e., specific gravity and Atterberg limits, were used as a basis for compositing the sediments (Table A14). Sediment samples CR-1 through CR-7, CR-29, and CR-30 were composited for Reach 1. Sediment samples CR-8 through CR-14 were composited for Reach 2 excluding CR-9 because the sample was very sandy. Sediment samples CR-15 through CR-28 were composited for Reach 3 excluding CR-22 and CR-23 because those samples were very sandy. More detailed results are in Table A14.

[1] A table of factors for converting non-SI units of measurement to SI units is presented on page viii.

**Table 1**
**Composite Schematic of Calcasieu River Sediment and Sample Collection**

| Reach No. | Sample No. | Sample Location |
|---|---|---|
| 1 | CR-1 | Mi 36.0 |
| | CR-2 | Mi 35.5 |
| | CR-3 | Mi 35.0 |
| | CR-4 | Mi 34.5 |
| | CR-5 | Mi 34.0 |
| | CR-6 | Mi 33.5 |
| | CR-7 | Mi 33.0 |
| | CR-29 | * |
| | CR-30 | ** |
| 2 | CR-8 | Mi 32.5 |
| | CR-10 | Mi 31.5 |
| | CR-11 | *** |
| | CR-12 | Mi 31.0 |
| | CR-13 | Mi 30.5 |
| | CR-14 | Mi 30.0 |
| 3 | CR-15 | Mi 29.5 |
| | CR-16 | Mi 29.0 |
| | CR-17 | Mi 28.5 |
| | CR-18 | Mi 28.0 |
| | CR-19 | Mi 27.5 |
| | CR-20 | Mi 27.0 |
| | CR-21 | Mi 26.5 |
| | CR-24 | Mi 25.0 |
| | CR-25 | Mi 24.5 |
| | CR-26 | Mi 24.0 |
| | CR-27 | Mi 23.5 |
| | CR-28 | Mi 23.0 |

Note:
* Confluence with Bayou (D'Inde).
** Clooney Island Loop (South End).
*** Clooney Island Loop (Middle).

## Settling tests

The settling tests followed procedures found in Palermo, Montgomery, and Poindexter (1978), U.S. Army Corps of Engineers (1987), and Palermo and Thackston (1988).

The tests involved mixing sediment and site water to simulate a dredged material slurry, placing the material in a settling column, and observing each

**Table 2**
**Total Solids Concentration of Composited Sediment Samples**

| Reach Number | Total Solids Concentration g/L | Average Total Solids Concentration, g/L |
|---|---|---|
| 1 | 831.6 | 791.2 |
| | 772.5 | |
| | 769.6 | |
| 2 | 775.9 | 762.6 |
| | 756.4 | |
| | 755.6 | |
| 3 | 798.8 | 790.2 |
| | 779.4 | |
| | 792.5 | |

of several types of settling (i.e., discrete, zone, flocculent, and compression) behavior. The general procedures are described below.

**Procedures.** Zone, flocculent, and compression settling data were collected by conducting settling test for each of the three composite samples. The three types of settling data were collected from a single settling test for each composite.

The flocculent settling test consisted of measuring the concentration of suspended solids at various depths and time intervals in a settling column. An interface formed near the top of the settling column during the first day of the test; therefore, sedimentation of the material below the interface is described by zone settling. The flocculent test procedure was continued only for that portion of the water column above the interface. Samples of the supernatant were extracted from each sampling port above the liquid-solid interface at different time intervals. The suspended solids concentrations of the extracted samples were determined. Substantial reductions of suspended solids are expected to occur during the early part of the test, but reductions should lessen at longer retention times (U.S. Army Corps of Engineers 1987).

The zone settling test consisted of placing a slurry in a sedimentation column and reading and recording the fall of the liquid-solids interface with time. These data are plotted as depth from the surface to the interface versus time. The slope of the constant velocity settling zone of the curve is the zone settling velocity, which is a function of the initial slurry concentration.

The compression settling test must be run to obtain data for estimating the volume required for initial storage of the dredged material. For slurries exhibiting zone settling, the compression settling data can be obtained by continuing the zone settling test for a period of 15 days so that a relationship of log of concentration versus log of time in the compression settling range is obtained (U.S. Army Corps of Engineers 1987).

**Slurry preparation.** The target slurry concentration selected for the settling tests was 150 g/L, the suggested default value for hydraulically dredged slurry since the actual dredged material influent concentration was not known. The slurry was prepared by mixing the Calcasieu River composite sediment with site water collected from the site. The site water salinity content was 3.0 ppt. The average solids concentrations for the sediment samples prior to mixing were 791.2, 762.6, and 790.2 g/L (Table 2) for Reaches 1, 2, and 3, respectively. To achieve the target slurry concentration for the composite materials, approximately 14, 15, and 14 L of sediment were mixed with 62, 61, and 62 L of site water using a Lightnin mixer. The slurry was pumped from each 55-gal drum with a positive displacement pump into three 8-in. diam, 7-ft columns, with ports at 0.5-ft intervals starting at the 7.0-ft depth (see Figure 3). After the slurry was thoroughly mixed and pumped into each column, six samples for total solids were extracted from ports at the 6.0-, 5.0-, 4.0-, 3.0-, 2.0-, and 1.0-ft level from each column. The average total solids concentrations for the slurry as pumped into the column were determined to be 84.0, 90.2, and 105.2 g/L for Reaches 1, 2, and 3, respectively. The difference between initial column total solids concentration and the concentration of slurry as mixed is due to sedimentation of the course fraction in the drums.

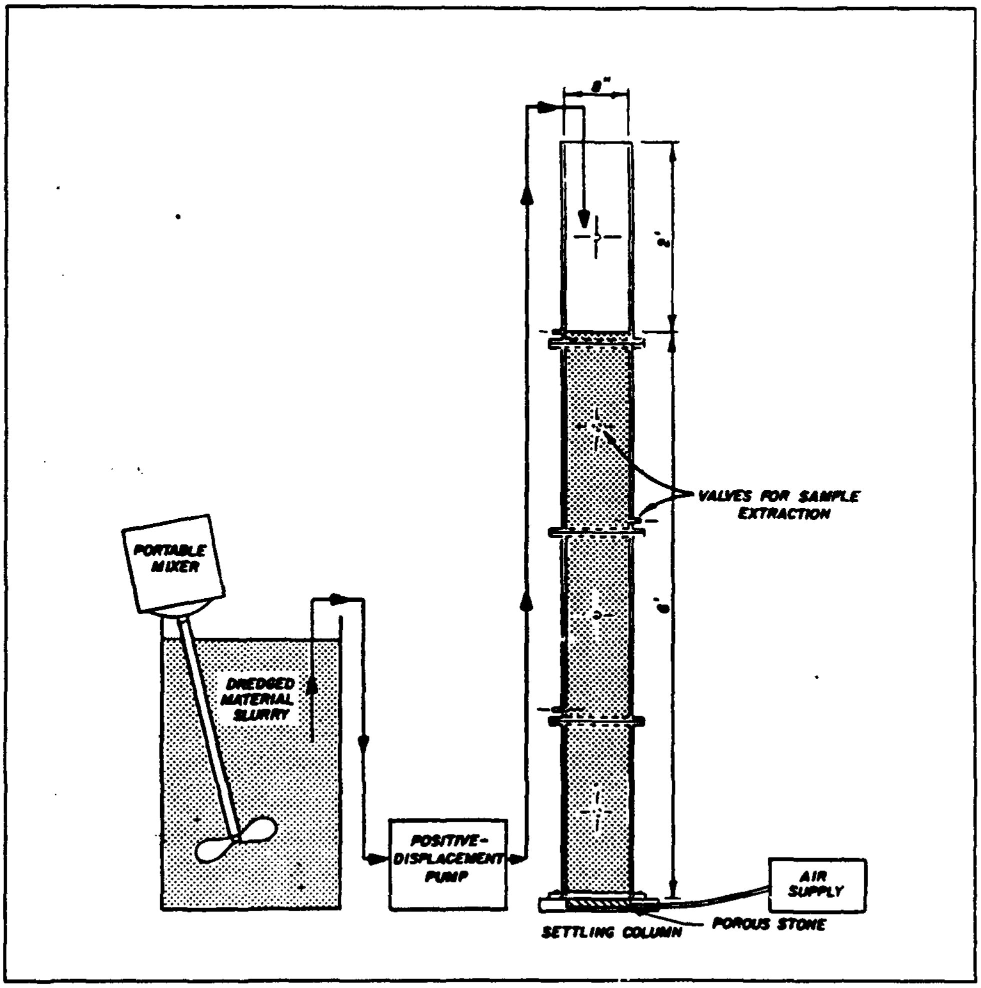


Figure 3. Schematic of settling column (from Palermo 1985)

**Zone test.** The zone settling test was performed concurrently with the compression settling test on the same slurry. The depth to the interface was read at approximately 15-min intervals for the first 4 hr and at 30-min intervals for the next 4 hr. From the plot of the depth to interface (feet) versus time (hours), zone settling velocity was determined.

**Compression test.** The depth to the interface was measured at approximately 15-min intervals for the first 4 hr and at 30-min intervals for the next 8 hr, which were the same times as those used for the zone test (as described above). Thereafter, for 15 days, depth to the interface was measured at 1- to 3-day intervals, and these data were used for the compression settling analysis.

**Flocculent test.** Flocculent settling tests were performed concurrently with the zone and compression settling tests on the same slurry. Therefore, the flocculent, zone, and compression settling test initial slurry concentrations were the same. Samples of the supernatant were extracted with a syringe at 6.0-, 5.5-, 5.0-, 4.5-, 4.0-, 3.5-, 3.0-, 2.5-, and 2.0-ft ports above the liquid-solid interface at different time intervals (2, 4, 6, 8, 12, 24, 48, 96, 168, 264, and 360 hr). Suspended solids concentrations were then determined on the supernatants by Standard Method 2540D (American Public Health Association (APHA) - American Water Works Association (AWWA) - Water Pollution Control Federation (WPCF) 1989). Turbidity of the supernatants was measured using a digital model 2008 turbidimeter and determined by Standard Method 2130B (APHA-AWWA-WPCF 1989).

### Modified elutriate test

The procedure for conducting a modified elutriate test, as shown in Figure 4, is described in the following paragraphs.

**Apparatus and testing procedure.** The modified elutriate testing apparatus consists of a laboratory mixer and several 4-L graduated cylinders. The volume required for each analysis, the number of parameters measured, and the desired analytical replication will influence the total elutriate sample volume required. The test procedure involves mixing site water and sediment to a concentration expected in the influent to a CDF. The mixture is then aerated for 1 hr to simulate the oxidizing conditions present at the disposal site. Next, the mixture is allowed to settle for a time equal to the expected or measured mean retention time of the disposal area, up to a maximum of 24 hr. The sample of the supernatant water is extracted for single analysis of dissolved and total contaminant concentrations. Detailed procedures for the modified elutriate test as conducted at WES are presented below.

**Sample preparation.** The sediment and dredging site water were mixed to a target slurry concentration of 150 g/L. Three composite sediment concentrations were 791.2, 762.6, and 790.2 g/L for Reaches 1, 2, and 3, respectively. Each 4-L cylinder to be filled required a mixed slurry volume of 3.75 L.

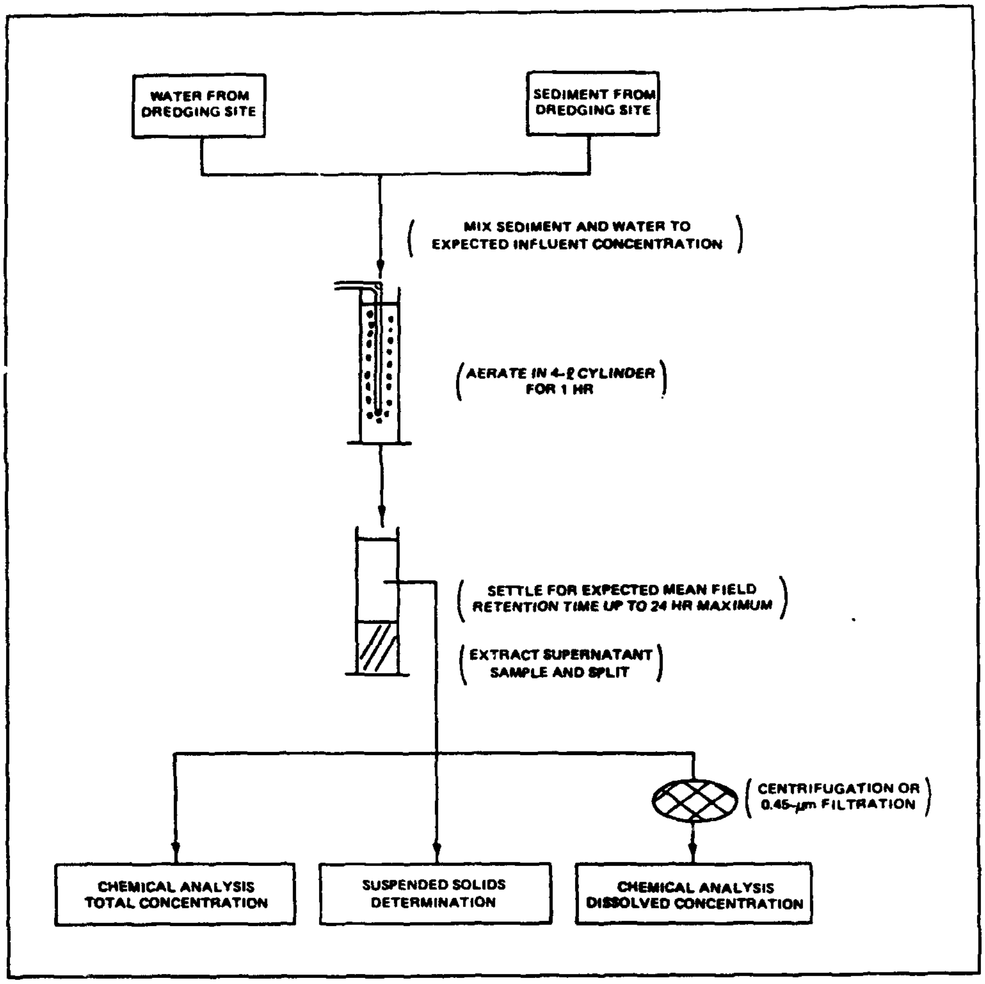


Figure 4. Modified elutriate test procedure

The volumes of sediment and dredging site water to be mixed in the cylinders were calculated using the following equations:

$$V_{sediment} = 3.75 \times (C_{slurry}/C_{sediment}) \tag{1}$$

$$V_{water} = 3.75 - V_{sediment} \tag{2}$$

where

$V_{sediment}$ = volume of sediment, L

3.75 = volume of slurry placed in a 4-L cylinder, L

$C_{slurry}$ = desired concentration of slurry, g/L

$C_{sediment}$ = predetermined concentration of sediment, g/L

$V_{water}$ = volume of dredging site water, L

The slurries were prepared by adding 0.71, 0.74, and 0.71 L of sediment to 3.04, 3.01, and 3.04 L of site water in three large containers for Reaches 1, 2, and 3, respectively.

**Mixing of slurry.** The slurries were mixed in large containers for 15 min with a laboratory mixer. The slurries were mixed to a uniform consistency.

**Aeration of slurry.** Aeration was used to ensure oxidizing conditions in the supernatant water to simulate dredging operation during the mixing phase. The mixed slurry was poured into 4-L graduated cylinders. The slurry was aerated by using compressed air that passed through a deionized water trap, through a glass tubing, and bubbled through the slurry. The agitation was vigorous and continued for 1 hr.

**Settling of slurry.** The tubing was then removed from the cylinder, thereby allowing the aerated slurry to undergo quiescent settling for 24 hr, a suggested default value when the field mean retention time is not known.

**Sample extraction.** After the 24-hr settling period, samples of the supernatant water were extracted from the cylinder at a point midway between the water surface and the interface using a syringe and tubing. Care was taken not to resuspend settled material. The extracted samples were homogenized, split, and analyzed for TSS concentration, dissolved contaminants, and total contaminants of selected constituents. Samples for the analysis of dissolved contaminants were filtered through a 0.45-μm millipore glass fiber filter.

## Data Analysis and Results

The behavior of Calcasieu River sediments at slurry concentrations equal to that expected for inflow to a CDF is governed by zone settling processes. The sediments exhibited a clear interface between settled material and clarified supernatant.

The settling test data were analyzed using the Automated Dredging and Disposal Alternatives Management System (ADDAMS) (Schroeder and Palermo 1990), which is a family of computer programs developed at WES to assist in planning, designing, and operating dredging and dredged material disposal projects.

All chemical analyses for this study were conducted according to SW-846 standard procedures (Table 3). Metals were analyzed using one of the following instruments: Inductively Coupled Argon Plasma (ICP), Perkin Elmer 5000 (Cold Vapor), and Zeeman 5100. Organic analyses were performed using gas chromatograph/mass spectrometers (GC/MS). The Environmental Chemistry Branch (ECB) at WES performed these analyses.

**Table 3**
**Laboratory Analytical Procedures**

| Parameter | Analytical Method | Reference |
|---|---|---|
| Base/Neutrals/Acid Extractables (BNA) | USEPA Method 8270 | SW-846 |
| Metals | USEPA Method 7470<br>USEPA 7000 Series/6010 | SW-846<br>SW-846 |
| Pesticides/PCBs | USEPA Method 8080 | SW-846 |
| Total Organic Carbon (TOC) | USEPA Method 9060 | SW-846 |
| Total Recoverable Petroleum Hydrocarbons (TRPH) | USEPA Method 418.1 | EPA-600 |
| Volatile Organic Compounds (VOC) | USEPA Method 8240 | SW-846 |

Note: USEPA = U.S. Environmental Protection Agency.
PCBs = Polychlorinated biphenyls.

## Bulk chemistry

Homogenized samples (in triplicate) of the sediment in each reach and site water (in duplicate) were sent to the ECB to determine their chemical characteristics. The sediment and site water were analyzed for total metals, organic priority pollutants including volatiles, TRPH, and TOC. The analysis of the sediment showed the average concentrations of heavy metals as follows: arsenic (2.27 mg/kg), chromium (9.35 mg/kg), copper (8.01 mg/kg), iron (7,688 mg/L), and lead (20 mg/kg) for Reach 1. The average pesticide concentration of D-BHC was 0.019 mg/kg for Reach 1. The average TOC concentration was 16,018, 19,331, and 10,344 mg/kg for Reaches 1, 2, and 3, respectively. Heavy metals were also detected in the site water. Tables A1-A6 show the bulk chemistry analysis results of sediment and site water for Reaches 1, 2, and 3, respectively.

## Modified elutriate test

Since the bulk chemistry results gave a "reason to believe" that the sediment may be contaminated, the modified elutriate test was conducted on the Calcasieu River sediment to evaluate the potential for contaminant releases from the CDF during dredging operations. Results for all analytes are shown in Table A7. The detected analytical results show total concentrations and dissolved concentrations of beryllium, antimony, and arsenic (Tables 4-6).

The chemical analysis of the modified elutriate samples provided the data used to predict dissolved and total concentrations of contaminants in milligrams per liter. The TSS concentration was also determined. TSS concentration for Reaches 1 and 2 was 564 and 70,227 mg/L, respectively. These

## Table 4
## Results of Modified Elutriate Tests for Reach 1

| Parameter | Total Concentration mg/L | Dissolved Concentration mg/L | Fraction of Total Suspended Solids mg/kg of TSS |
|---|---|---|---|
| Beryllium | 0.001 | <0.001[a] | 1.77 |
| Cadmium | 0.00021 | <0.00020 | 0.3723 |
| Chromium | 0.012 | <0.0010 | 21.3 |
| Lead | 0.0063 | <0.0010 | 11.2 |
| Mercury | 0.0009 | <0.0002 | 1.60 |
| Nickel | 0.008 | <0.001 | 14.2 |
| Zinc | 0.062 | <0.010 | 109.9 |
| Iron | 7.29 | <0.025 | 12,926 |
| TSS | 564 | --- | --- |

[a] "<" values were assigned zero.

## Table 5
## Results of Modified Elutriate Tests for Reach 2

| Parameter | Total Concentration mg/L | Dissolved Concentration mg/L | Fraction of Total Suspended Solids mg/kg of TSS |
|---|---|---|---|
| Antimony | 0.0106 | <0.0030[a] | 0.1509 |
| Arsenic | 0.0648 | <0.0020 | 0.9227 |
| Beryllium | 0.039 | 0.001 | 0.541 |
| Cadmium | 0.00263 | <0.00020 | 0.03745 |
| Chromium | 1.30 | <0.0010 | 18.5 |
| Copper | 0.659 | <0.001 | 9.38 |
| Lead | 0.667 | <0.0010 | 9.50 |
| Mercury | 0.0042 | <0.0002 | 0.0598 |
| Nickel | 0.737 | <0.001 | 10.5 |
| Selenium | 0.0184 | <0.0020 | 0.2620 |
| Thallium | 0.0030 | <0.0020 | 0.0427 |
| Zinc | 2.16 | <0.010 | 30.8 |
| Iron | 699 | <0.025 | 9,953 |
| TRPH | 2.3 | <0.63 | 32.8 |
| TSS | 70,227 | --- | --- |

[a] "<" values were assigned zero.

**Table 6**
**Results of Modified Elutriate Tests for Reach 3**

| Parameter | Total Concentration mg/L | Dissolved Concentration mg/L | Fraction of Total Suspended Solids mg/kg of TSS |
|---|---|---|---|
| Antimony | 0.0044 | 0.0030 | 43.8 |
| Arsenic | 0.0029 | 0.0023 | 18.8 |
| Beryllium | 0.001 | <0.001[a] | 31.3 |
| Cadmium | 0.00043 | <0.00020 | 13.4 |
| Chromium | 0.0011 | <0.0010 | 34.4 |
| Lead | 0.0045 | <0.0010 | 140.6 |
| Mercury | 0.0003 | <0.0002 | 9.38 |
| Nickel | 0.008 | <0.001 | 250.0 |
| Zinc | 0.163 | <0.010 | 5,094 |
| Iron | 0.392 | <0.025 | 12,250 |
| TSS | 32 | — | — |

[a] "<" values were assigned zero.

elevated levels of TSS were not typical of similar sediment. A possible explanation is that little to no interface developed after 24 hr of settling. Therefore, the effluent samples resulted in elevated levels of TSS for both reaches. The TSS concentration for Reach 3 is more representative of similar sediment. The TSS concentration for appropriate reaches will be used in Equation 3 below.

To predict the total concentration of each contaminant in the effluent, it was necessary to first calculate the fraction of each contaminant associated with the TSS in the elutriate samples using the following equation:

$$F_{ss} = (1 \times 10^6) \times \frac{(C_{total} - C_{diss})}{SS} \qquad (3)$$

where

$F_{ss}$ = fraction of contaminant in TSS, mg contaminant/kg of suspended solids

$(1 \times 10^6)$ = conversion factor, mg/mg to mg/kg

$C_{total}$ = total concentration, mg contaminant/L of sample

$C_{diss}$ = dissolved concentration, mg contaminant/L of sample

$SS$ = total suspended solids concentration, mg solids/L of sample

The results for these calculations using Equation 3 are summarized in Tables 4-6, which show only the detected parameters.

### Column settling tests

**Compression settling tests.** For the compression tests, the initial slurry concentration and height and depth to interface versus time were entered (Tables A8-A10). The ADDAMS program used the initial slurry concentrations of 83.95, 90.19, 105.19 g/L and heights of 6.25, 6.23, 6.29 ft to determine the solids concentration at a given time for Reaches 1, 2, and 3, respectively. A plot was generated showing the relationship between solids concentration (grams/liter) and retention time (days) (Figure 5). ADDAMS also developed a regression equation for the resulting power curve relating solids concentration to time. The composite sample regression equation may be used to determine the solids concentration at any given time. The regression equation used was as follows:

$$C = 205 \times T^{0.178} \text{ for Reach 1} \tag{4}$$

$$C = 197 \times T^{0.161} \text{ for Reach 2} \tag{5}$$

$$C = 211 \times T^{0.166} \text{ for Reach 3} \tag{6}$$

where

$C$ = solids concentration, g/L

$T$ = time, days

Slopes of the solids concentration versus time curves for all three sediment samples were similar (Figure 5). However, the solids concentration after 1 day of settling was different because the zone settling velocities were different. The sediment sample from Reaches 1 and 3 settled faster the first few hours than Reach 2, causing Reaches 1 and 3 sediments to exhibit compression settling at a greater solids concentration with time (Figure 6).

**Zone settling test.** Zone settling velocity for the Calcasieu River composite sample was determined to be 0.265, 0.220, 0.155 ft/hr for the zone test for Reaches 1, 2, and 3, respectively. Depths to interface and their corresponding time intervals were entered (Tables A11-A13) into a plotting routine used to

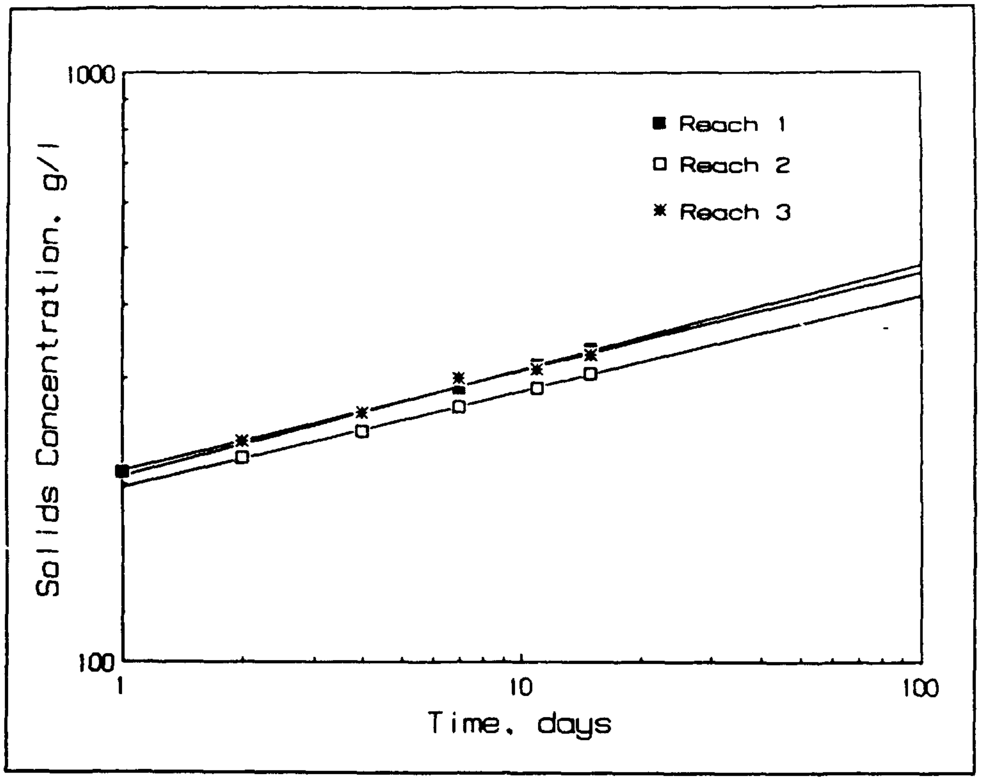


Figure 5. Compression test curves for Reaches 1, 2, and 3

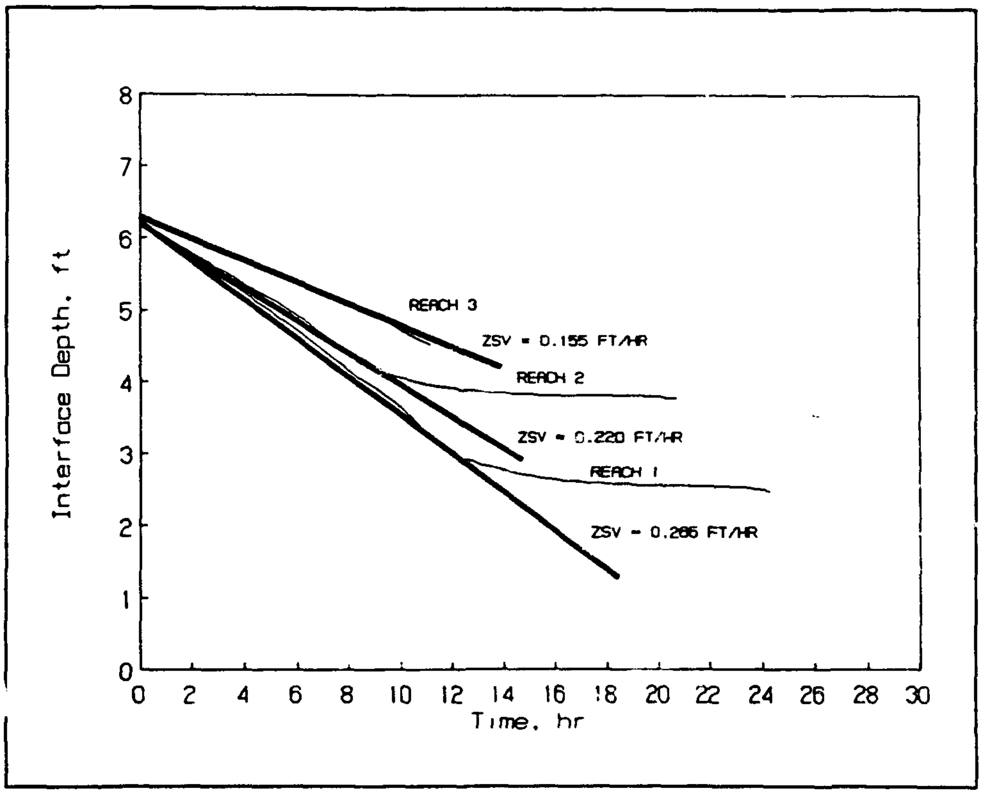


Figure 6. Zone settling curves for Reaches 1, 2, and 3

determine the zone settling velocity. When the zone settling curve departs from a linear relationship, compression settling begins (Figure 6).

**Flocculent settling tests.** For the flocculent tests, an extension to this procedure is presented in U.S. Army Corps of Engineers (1987). Palermo (1984) analyzed the effects of several possible assumptions regarding the magnitude of the value to be used as the initial concentration in the laboratory test, and he showed that all gave essentially the same final result. Therefore, he recommended that, for simplicity, the concentration in the first sample taken at the highest sampling port be used as the initial concentration. The initial concentration and the supernatant suspended solids concentrations at different depths and time intervals (Tables A14-A16) were used by ADDAMS to generate two curves, the concentration profile curve (Figures 7, 9, and 11 for Reaches 1, 2, and 3, respectively) and the supernatant suspended solids curve (Figures 8, 10, and 12 for Reaches 1, 2, and 3, respectively). The concentration profile curve, which plots the depth below the surface (feet) versus percent of initial concentration, shows that the suspended solids concentrations decrease with time and increase at deeper ponding depths (1-, 2-, and 3-ft) at the weir. The supernatant suspended solids curves derived from the concentration profile curves compare the effect of retention time on supernatant suspended solids at 1-, 2-, and 3-ft ponding depths. This curve shows that increasing the retention time beyond 70, 50, and 100 hr for 2 ft of ponding depth provides little additional improvement in supernatant suspended solids concentration for Reaches 1, 2, and 3, respectively.

Reach 3 supernatant suspended solids at the 2-ft ponding depth settled more efficiently than Reaches 1 and 2, resulting in a slightly lower supernatant solids concentration. In other words, better suspended solids removal is possible with the Reach 3 material when compared with the other reaches sediment at a given retention time. Actual field suspended solids will be greater because of resuspension by wind and wave action. The resuspension factor is estimated at approximately 1.5 to 2.5 depending on ponding depth and surface area (Table 7).

**Turbidity.** Extra samples of the supernatant from the flocculent tests were collected to measure turbidity of corresponding TSS concentration (Tables 8-10). TSS will be used as an indicator of overall performance of CDFs, both for solids retention and for most other contaminants, which are strongly associated by adsorption or ion exchange. As mentioned earlier, turbidity is much more easily measured than TSS and may be used instead of TSS during routine operational monitoring.

Correlation curves between turbidity and TSS were established for each reach (Figures 13-15). The curves will assist field inspectors and others in measuring the effluent with a turbidity meter and extracting a TSS concentration from the appropriate curve (Figures 13-15). This readily available TSS concentration may ensure onsite compliance with state and/or Federal TSS standards. Samples for TSS measurement can be collected less frequently for

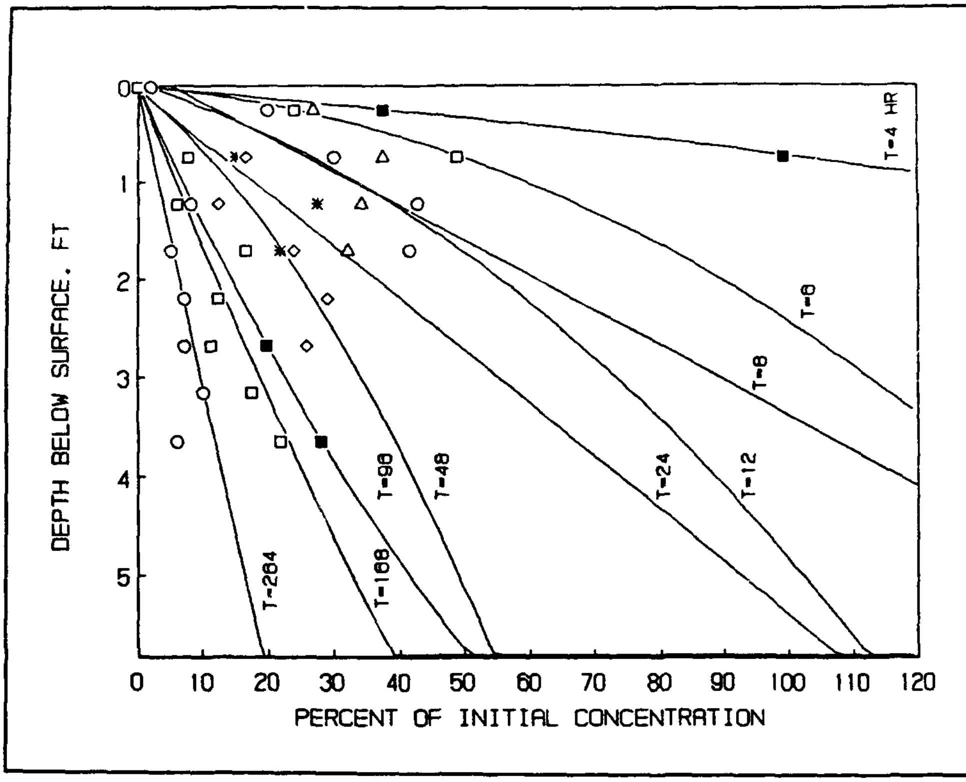


Figure 7. Solids concentration profile curve for Reach 1

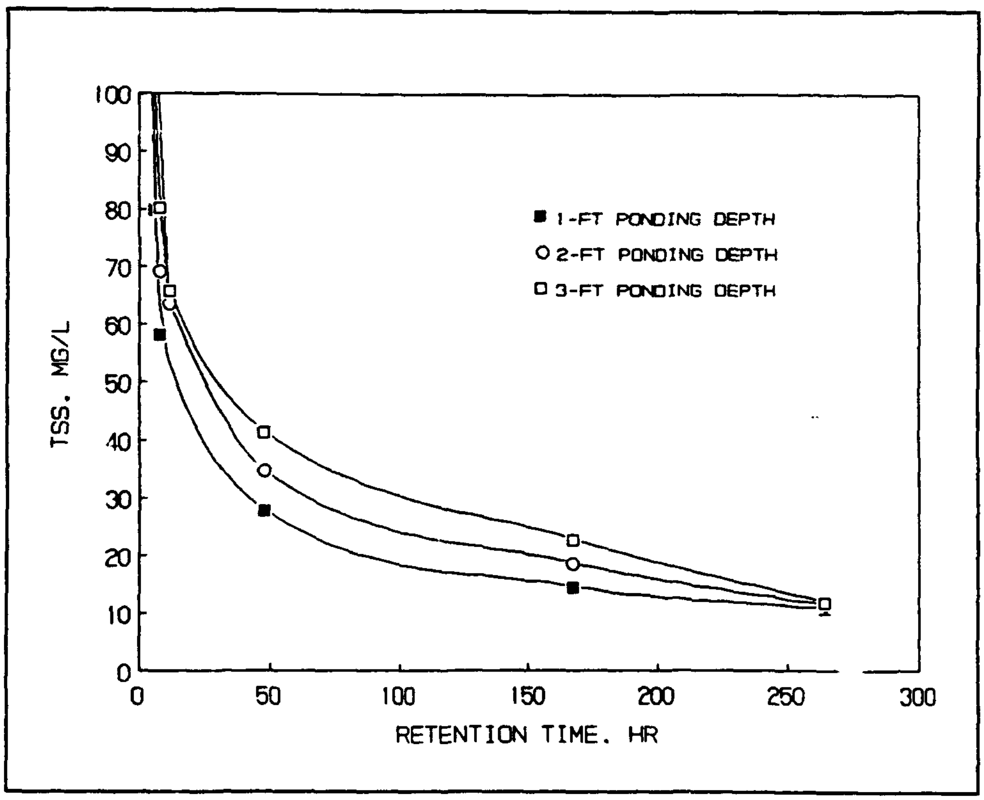


Figure 8. Supernatant suspended solids curves for Reach 1

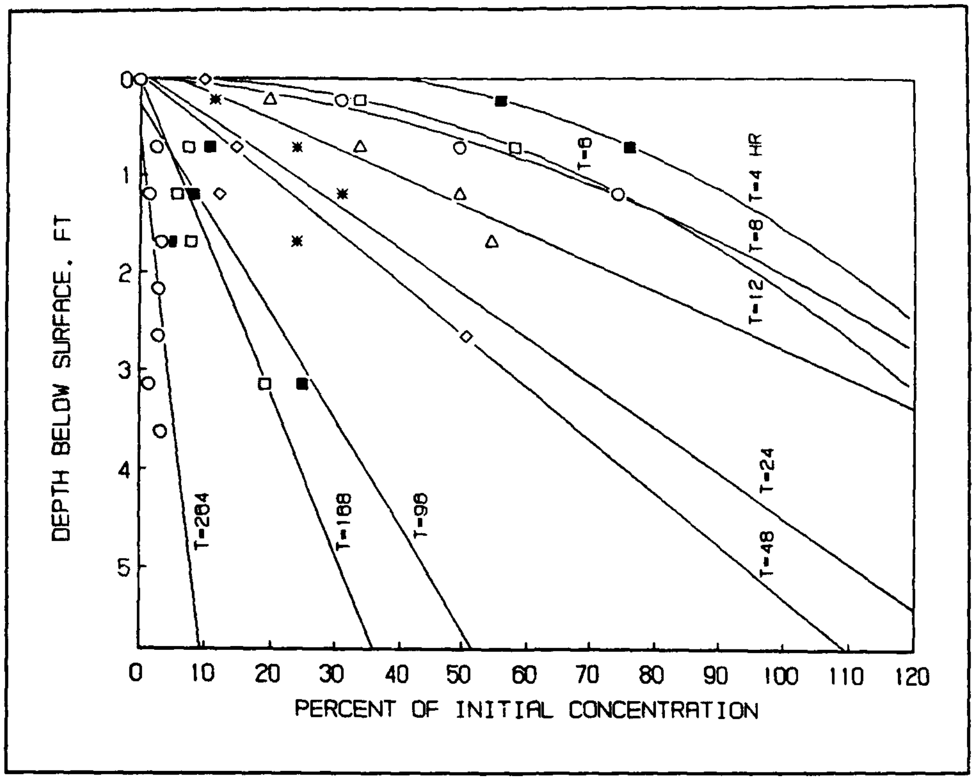


Figure 9. Solids concentration profile curve for Reach 2

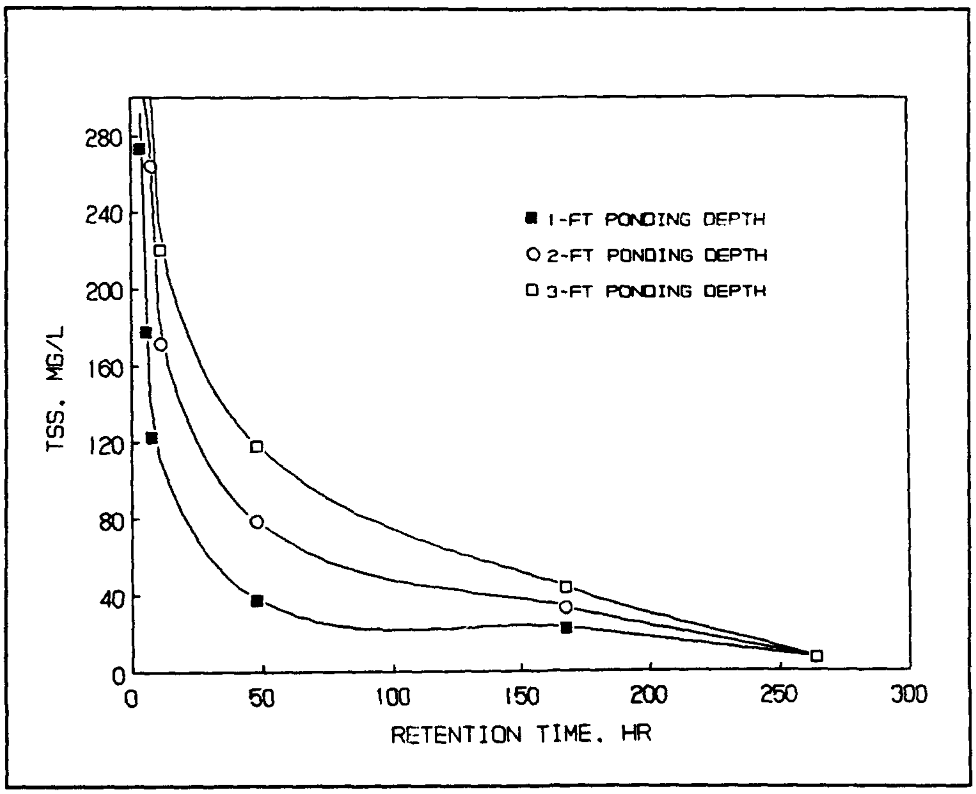


Figure 10. Supernatant suspended solids curves for Reach 2

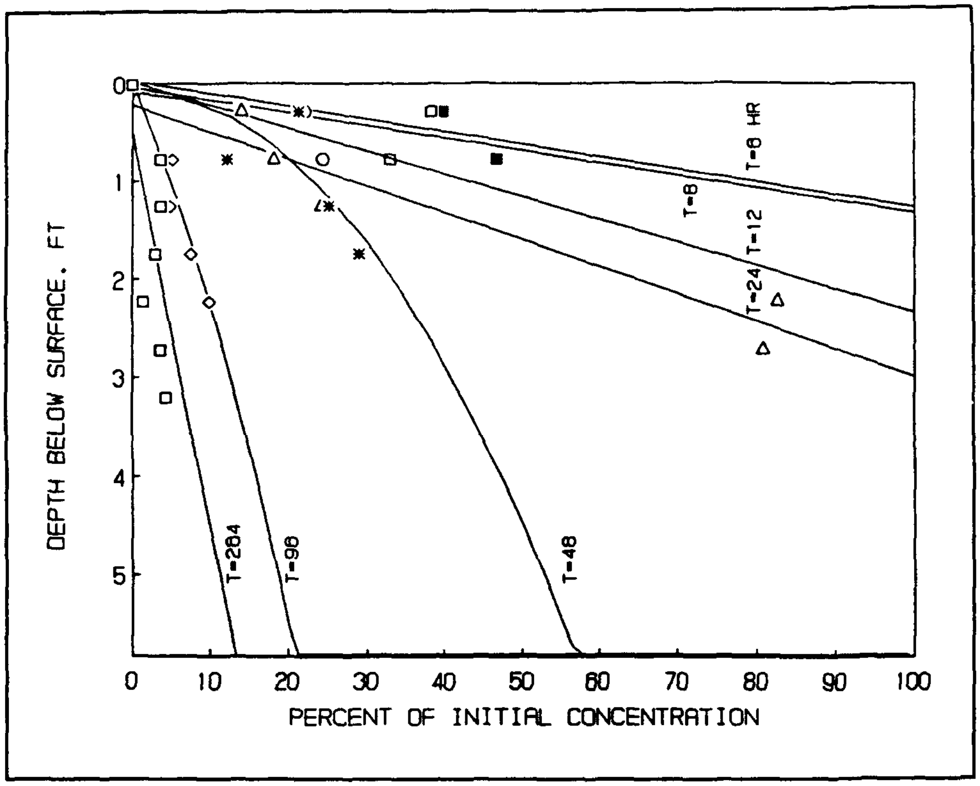


Figure 11. Solids concentration profile curve for Reach 3

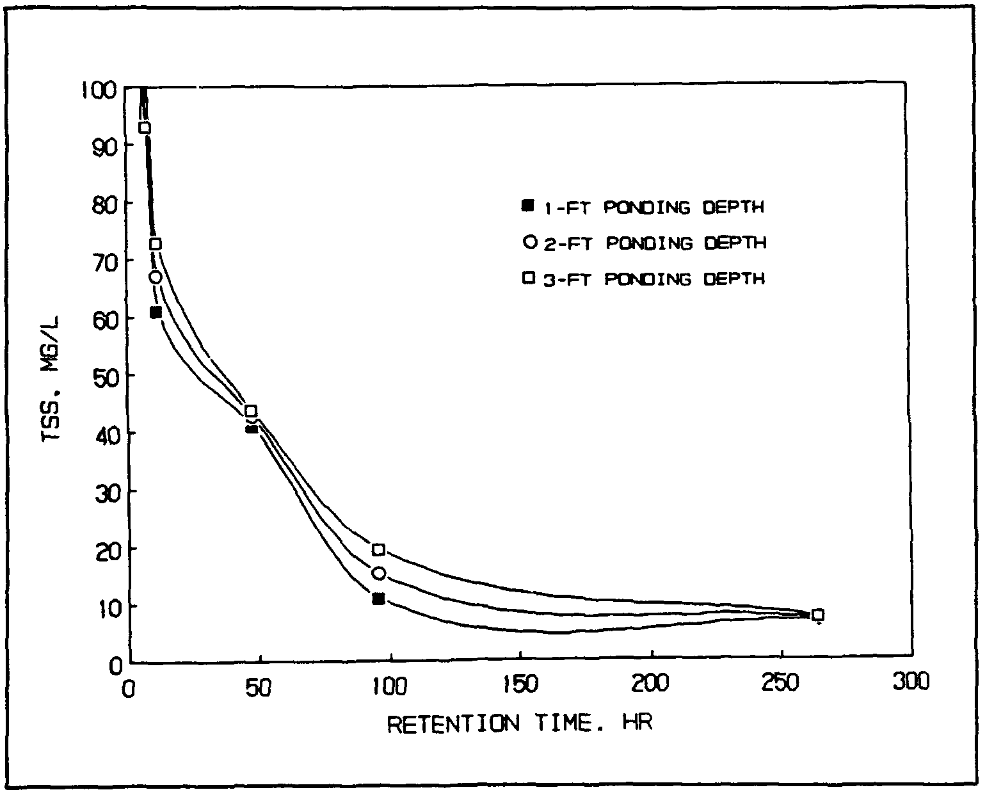


Figure 12. Supernatant suspended solids curves for Reach 3

**Table 7**
**Recommended Resuspension Factors for Various Ponded Areas and Depths**

| Anticipated Ponded Area | Anticipated Average Ponded Depth | |
|---|---|---|
| | Less than 2 ft | 2 ft or Greater |
| Less than 100 acres | 2.0 | 1.5 |
| Greater than 100 acres | 2.5 | 2.0 |

compliance monitoring and to field verify the correlations for laboratory samples.

Slopes of the correlation curve for Reaches 1 and 2 are similar. However, the slope of the correlation curve for Reach 3 will yield a lower TSS concentration. The correlation curves for each reach are not interchangeable. Therefore, TSS concentrations for Reach 1 are valid only when extracted from Reach 1 correlation curve.

## Application of Results to Conceptual Design of a Typical CDF

### Sediment characteristics

Sediment characteristics of the dredged material are important in the design of a CDF. Average sediment physical characteristics for the Calcasieu River based on the data presented in Table A17 are listed in Table 11. More detailed physical characteristics of the Calcasieu River are listed in Table A7. Predominant unified soil classification is organic clay (OL).

### Typical project conditions

Preliminary design of a CDF also requires knowledge of specific project conditions. The dredge production rate, dredge flow rate, site capacity, dike height, sediment storage depth, ponding depth, and freeboard depth are needed (Wade 1988). For the purpose of illustrating how to use the information developed in this study, the following project conditions are assumed: (a) volumes to dredge are 1,400,000, 1,600,000, and 3,000,000 $yd^3$ for Reaches 1, 2, and 3, respectively; (b) 27-in. dredge may be used and expected to dredge at an effective production rate of 1,500 $yd^3/hr$; (c) dredged material slurry flow rate is 8,000 $yd^3/hr$ (60 cfs) for a slurry concentration of 150 g/L; (d) the ponded area covers 50 percent of the surface area; and (e) the dike, storage, ponding, and freeboard depths are 10, 6, 2, and 2 ft, respectively.

**Table 8**
**TSS Concentrations and Turbidity Measurements from Reach 1 Settling Test Data**

| Time hr | Port No. | Total Suspended Solids mg/L | Turbidity NTU[1] |
|---|---|---|---|
| 2 | 6.0 | 191 | 18.3 |
| 4 | 6.0 | 72 | 18.1 |
| 4 | 5.5 | 190 | 23.9 |
| 6 | 6.0 | 46 | 8.9 |
| 6 | 5.5 | 94 | 8.1 |
| 6 | 5.0 | 96 | 14.9 |
| 8 | 6.0 | 38 | 7.9 |
| 8 | 5.5 | 58 | 15.5 |
| 8 | 5.0 | 82 | 6.2 |
| 8 | 4.5 | 80 | 15.6 |
| 12 | 6.0 | 52 | 7.1 |
| 12 | 5.5 | 72 | 9.9 |
| 12 | 5.0 | 66 | 7.8 |
| 12 | 4.5 | 62 | 13.3 |
| 12 | 4.0 | 294 | 13.0 |
| 12 | 3.5 | 332 | 26.1 |
| 24 | 5.5 | 29 | 6.6 |
| 24 | 5.0 | 53 | 16.1 |
| 24 | 4.5 | 42 | 6.9 |
| 24 | 4.0 | 131 | 39.8 |
| 24 | 3.5 | 676 | 25.2 |
| 24 | 3.0 | 506 | 152.0 |
| 48 | 5.5 | 32 | 4.2 |
| 48 | 5.0 | 24 | 3.1 |
| 48 | 4.5 | 46 | 5.4 |
| 48 | 4.0 | 56 | 4.5 |
| 48 | 3.5 | 50 | 3.7 |
| 48 | 3.0 | 202 | 59.2 |
| 48 | 2.5 | 230 | 35.8 |
| 96 | 5.5 | 136 | 22.5 |
| 96 | 5.0 | 96 | 26.4 |
| 96 | 4.5 | 58 | 15.8 |
| 96 | 4.0 | 18 | 5.0 |
| 96 | 3.5 | 38 | 9.2 |
| 96 | 3.0 | 137 | 50.0 |
| 96 | 2.5 | 54 | 15.4 |

*(Continued)*

[1] Nephelometric turbidity units.

| Table 8 (Concluded) | | | |
|---|---|---|---|
| Time<br>hr | Port No. | Total Suspended Solids<br>mg/L | Turbidity<br>NTU |
| 168 | 5.5 | 15 | 3.0 |
| 168 | 5.0 | 12 | 2.7 |
| 168 | 4.5 | 32 | 2.3 |
| 168 | 4.0 | 24 | 5.5 |
| 168 | 3.5 | 22 | 4.2 |
| 168 | 3.0 | 34 | 16.1 |
| 168 | 2.5 | 42 | 9.5 |
| 168 | 2.0 | 430 | 150.2 |
| 264 | 5.5 | 22 | 2.6 |
| 264 | 5.0 | 16 | 2.7 |
| 264 | 4.5 | 10 | 2.5 |
| 264 | 4.0 | 14 | 2.7 |
| 264 | 3.5 | 14 | 2.8 |
| 264 | 3.0 | 20 | 9.9 |
| 264 | 2.5 | 12 | 12.0 |
| 264 | 2.0 | 36 | 84.7 |
| 360 | 5.5 | 24 | 8.7 |
| 360 | 5.0 | 18 | 2.3 |
| 360 | 4.5 | 14 | 1.9 |
| 360 | 4.0 | 18 | 1.7 |
| 360 | 3.5 | 26 | 5.3 |
| 360 | 3.0 | 2 | 3.5 |
| 360 | 2.5 | 22 | 5.9 |
| 360 | 2.0 | 44 | 63.8 |

A 30- and 36-in. dredge may also be used and expected to dredge at an effective production rate of 1,900 and 2,700 $yd^3/hr$, respectively. The calculations based on the assumptions made earlier were entered into ADDAMS and are presented in Table 12.

### Design of a CDF for storage volume

Because dredged material has the tendency to increase in volume, the actual amount of dredged material from the three reaches at Calcasieu River requiring storage may be larger than 1,400,000, 1,600,000, and 3,000,000 $yd^3$ for Reaches 1, 2, and 3, respectively. The total volume required for initial storage in a containment area includes volume for storage of dredged material, volume for clarification (ponding depth), and freeboard volume (volume above water surface). The volume required for storage of the coarse-grained material (>No. 200 sieve) is determined separately because this material behaves

**Table 9**
**TSS Concentrations and Turbidity Measurements from Reach 2 Settling Test Data**

| Time hr | Port No. | Total Suspended Solids, mg/L | Turbidity NTU |
|---|---|---|---|
| 2 | 6.0 | 406 | 20.3 |
| 4 | 6.0 | 228 | 59 |
| 4 | 5.5 | 310 | 28.4 |
| 6 | 6.0 | 138 | 19.3 |
| 6 | 5.5 | 236 | 57.5 |
| 8 | 6.0 | 126 | 29.2 |
| 8 | 5.5 | 202 | 51.0 |
| 8 | 5.0 | 302 | 33.2 |
| 12 | 6.0 | 80 | 11.4 |
| 12 | 5.5 | 138 | 49.2 |
| 12 | 5.0 | 202 | 62.8 |
| 12 | 4.5 | 222 | 21.8 |
| 12 | 4.0 | 402 | 61.2 |
| 24 | 6.0 | 47 | 11.4 |
| 24 | 5.5 | 98 | 27.4 |
| 24 | 5.0 | 127 | 39.8 |
| 24 | 4.5 | 98 | 30.9 |
| 24 | 4.0 | 426 | 102.6 |
| 24 | 3.5 | 464 | 127.0 |
| 24 | 3.0 | 622 | 143.0 |
| 48 | 5.5 | 60 | 5.8 |
| 48 | 5.0 | 50 | 4.5 |
| 48 | 4.5 | 40 | 8.1 |
| 48 | 4.0 | 38 | 5.4 |
| 48 | 3.5 | 206 | 15.8 |
| 48 | 3.0 | 462 | 30.2 |
| 96 | 5.5 | 44 | 12.2 |
| 96 | 5.0 | 34 | 9.5 |
| 96 | 4.5 | 20 | 7.4 |
| 96 | 4.0 | 18 | 7.0 |
| 96 | 3.5 | 160 | 49.0 |
| 96 | 3.0 | 102 | 29.5 |
| 96 | 2.5 | 246 | 75.0 |

*(Continued)*

| Table 9 (Concluded) | | | |
|---|---|---|---|
| Time hr | Port No. | Total Suspended Solids, mg/L | Turbidity NTU |
| 168 | 5.5 | 31 | 4.2 |
| 168 | 5.0 | 24 | 4.2 |
| 168 | 4.5 | 32 | 4.8 |
| 168 | 4.0 | 24 | 4.2 |
| 168 | 3.5 | 38 | 13.9 |
| 168 | 3.0 | 78 | 17.4 |
| 168 | 2.5 | 138 | 45.0 |
| 264 | 5.5 | 11 | 10.4 |
| 264 | 5.0 | 6 | 2.2 |
| 264 | 4.5 | 14 | 4.6 |
| 264 | 4.0 | 12 | 3.1 |
| 264 | 3.5 | 12 | 7.6 |
| 264 | 3.0 | 6 | 4.1 |
| 264 | 2.5 | 14 | 42.9 |
| 264 | 2.0 | 76 | 92.7 |
| 360 | 5.5 | 42 | 16.4 |
| 360 | 5.0 | 20 | 5.3 |
| 360 | 4.5 | 18 | 4.3 |
| 360 | 4.0 | 22 | 4.2 |
| 360 | 3.5 | 20 | 5.7 |
| 360 | 3.0 | 12 | 2.4 |
| 360 | 2.5 | 134 | 45.8 |
| 360 | 2.0 | 400 | 88.0 |

independently of the fine-grained material (<No. 200 sieve). Design computations are as follows:

*a.* Representative samples of channel sediments tested in the laboratory indicate that 44.3, 48.4, and 45.5 percent of the sediment for Reaches 1, 2, and 3, respectively, is coarse-grained material (>No. 200 sieve). Therefore,

$$V_{sd1} = 1{,}400{,}000(0.443) = 620{,}200 \text{ yd}^3$$

$$V_{i1} = 1{,}400{,}000 - 620{,}200 = 779{,}800 \text{ yd}^3$$

$$V_{sd2} = 1{,}600{,}000(0.484) = 774{,}400 \text{ yd}^3$$

$$V_{i2} = 1{,}600{,}000 - 774{,}400 = 825{,}600 \text{ yd}^3$$

$$V_{sd3} = 3{,}000{,}000(0.455) = 1{,}365{,}000 \text{ yd}^3$$

**Table 10**
**TSS Concentrations and Turbidity Measurements from Reach 3 Settling Test Data**

| Time hr | Port No. | Total Suspended Solids, mg/L | Turbidity NTU |
|---|---|---|---|
| 4 | 6.0 | 260 | 12.5 |
| 6 | 6.0 | 104 | 16.8 |
| 6 | 5.5 | 122 | 34.0 |
| 8 | 6.0 | 100 | 14.8 |
| 8 | 5.5 | 86 | 18.4 |
| 12 | 6.0 | 58 | 14.6 |
| 12 | 5.5 | 64 | 14.2 |
| 12 | 5.0 | 284 | 50.6 |
| 24 | 6.0 | 37 | 10.5 |
| 24 | 5.5 | 48 | 14.9 |
| 24 | 5.0 | 64 | 20.9 |
| 24 | 4.5 | 294 | 68.5 |
| 24 | 4.0 | 215 | 79.9 |
| 24 | 3.5 | 210 | 69.0 |
| 48 | 6.0 | 56 | 8.5 |
| 48 | 5.5 | 32 | 2.8 |
| 48 | 5.0 | 66 | 12.5 |
| 48 | 4.5 | 76 | 18.0 |
| 48 | 4.0 | 136 | 46.0 |
| 48 | 3.5 | 212 | 39.7 |
| 48 | 3.0 | 280 | 54.0 |
| 96 | 5.5 | 14 | 3.8 |
| 96 | 5.0 | 13 | 3.6 |
| 96 | 4.5 | 20 | 7.2 |
| 96 | 4.0 | 26 | 10.6 |
| 96 | 3.5 | 250 | 97.0 |
| 96 | 3.0 | 114 | 41.0 |
| 168 | 5.5 | 30 | 2.3 |
| 168 | 5.0 | 22 | 1.5 |
| 168 | 4.5 | 36 | 9.6 |
| 168 | 4.0 | 52 | 15.7 |
| 168 | 3.5 | 68 | 20.2 |
| 168 | 3.0 | 108 | 26.4 |
| 168 | 2.5 | 326 | 124.7 |

*(Continued)*

| Table 10 (Concluded) | | | |
|---|---|---|---|
| Time hr | Port No. | Total Suspended Solids, mg/L | Turbidity NTU |
| 264 | 5.5 | 10 | 3.1 |
| 264 | 5.0 | 10 | 1.5 |
| 264 | 4.5 | 8 | 3.8 |
| 264 | 4.0 | 4 | 5.1 |
| 264 | 3.5 | 10 | 13.9 |
| 264 | 3.0 | 12 | 14.8 |
| 264 | 2.5 | 44 | 68.4 |
| 360 | 5.5 | 400 | 3.0 |
| 360 | 5.0 | - | 1.5 |
| 360 | 4.5 | 18 | 2.3 |
| 360 | 4.0 | 18 | 2.3 |
| 360 | 3.5 | 21 | 8.6 |
| 360 | 3.0 | - | 8.9 |
| 360 | 2.5 | 72 | 31.4 |

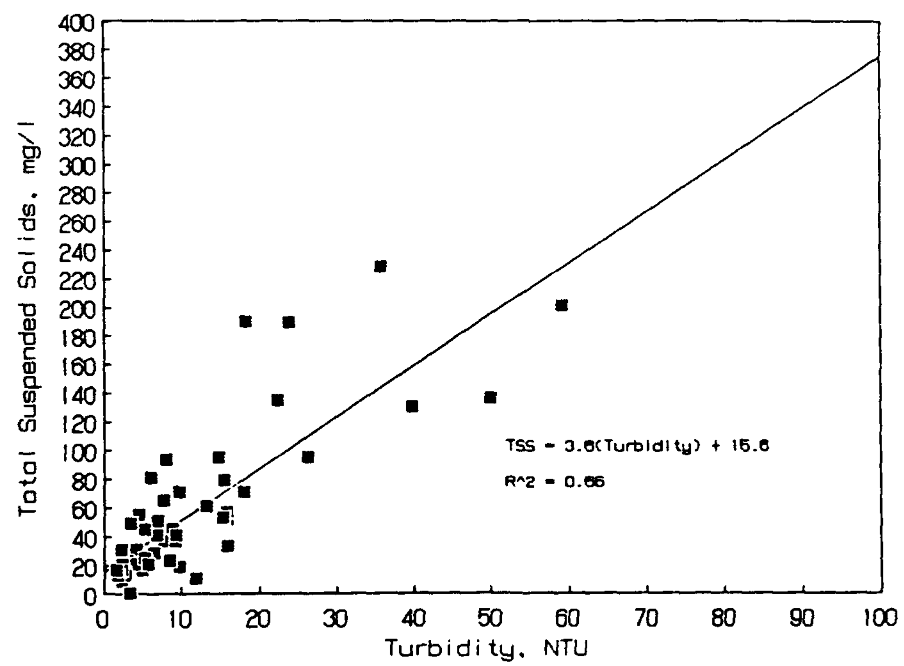


Figure 13. TSS versus turbidity measurements for Reach 1

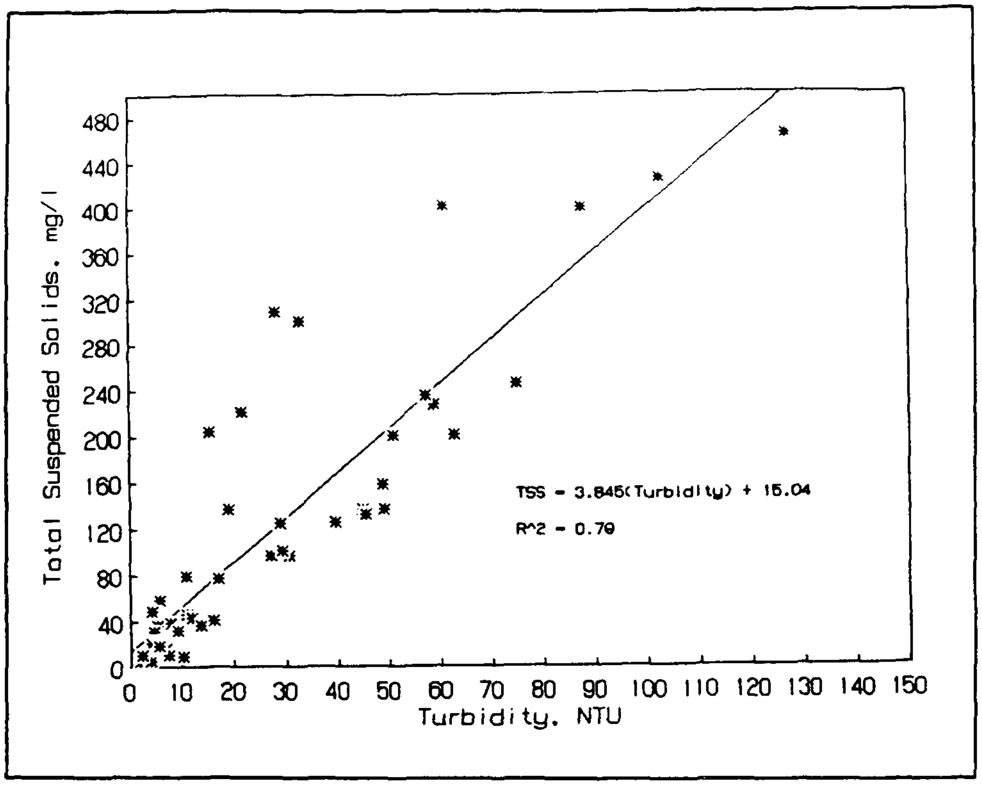


Figure 14. TSS versus turbidity measurements for Reach 2

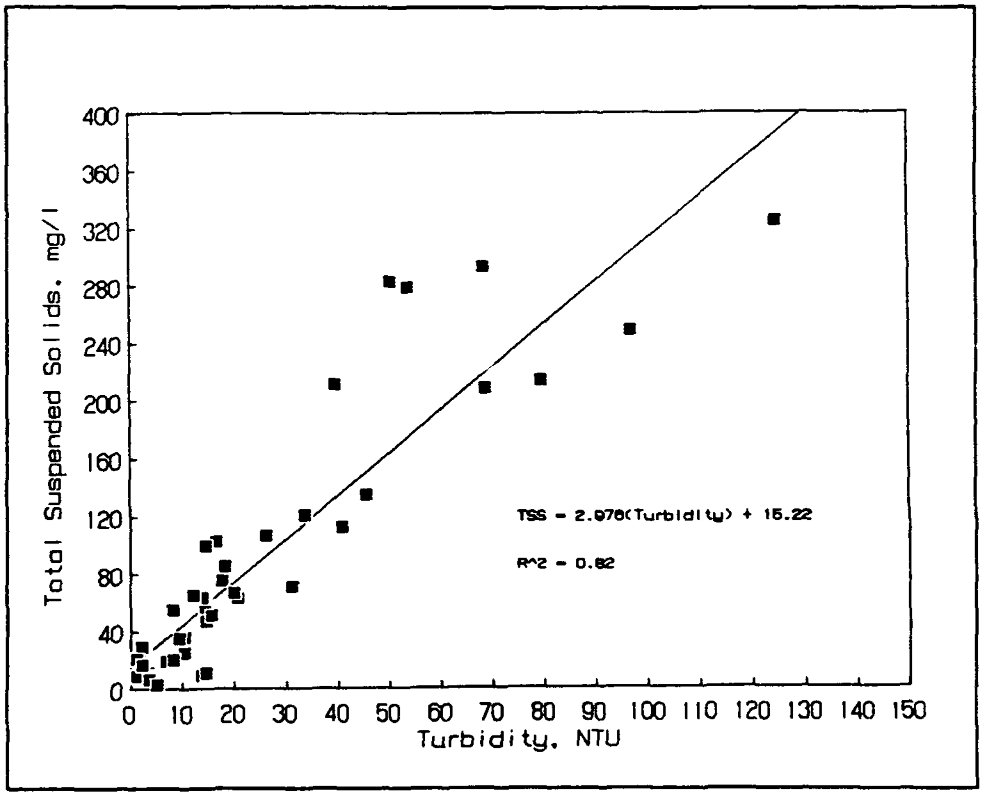


Figure 15. TSS versus turbidity measurements for Reach 3

**Table 11**
**Calcasieu River Reaches Sediment Physical Characteristics**

| Sediment Characteristic | Average Values Reach 1 | Reach 2 | Reach 3 |
|---|---|---|---|
| Initial water content, % | 96 | 200 | 114 |
| Specific gravity | 2.57 | 2.39 | 2.57 |
| Initial void ratio | 2.47 | 4.78 | 2.93 |
| Percent sand, % | 44.3 | 48.4 | 45.5 |

**Table 12**
**Calcasieu River CDF Design for Reaches 1, 2, and 3**

| Dredge Size, in. | Material to Dredge cu yd | CDF Size acre-ft[1] | Minimum Surface Area acres[2] | Maximum Effluent TSS mg/L[3] | Maximum Turbidity NTU[4] | Critical Contaminant[3] |
|---|---|---|---|---|---|---|
| **Reach 1** | | | | | | |
| 27 | 1,400,000 | 1,426 | 70 | 24,000 | 6,662 | Zn |
| 30 | 1,400,000 | 1,468 | 87 | 19,500 | 5,412 | Zn |
| 36 | 1,400,000 | 1,541 | 125 | 13,800 | 3,829 | Zn |
| **Reach 2** | | | | | | |
| 27 | 1,600,000 | 1,670 | 84 | 3,575 | 926 | Cu |
| 30 | 1,600,000 | 1,711 | 104 | 3,050 | 789 | Cu |
| 36 | 1,600,000 | 1,786 | 150 | 2,350 | 607 | Cu |
| **Reach 3** | | | | | | |
| 27 | 3,000,000 | 2,790 | 120 | 515 | 168 | Zn |
| 30 | 3,000,000 | 2,860 | 148 | 420 | 136 | Zn |
| 36 | 3,000,000 | 2,985 | 213 | 300 | 96 | Zn |

[1] CDF size required for initial storage was determined using the ADDAMS/SETTLE model.
[2] Minimum surface area required for clarification.
[3] Maximum Effluent TSS and critical contaminant were determined using the ADDAMS/EFQUAL model, which indicates the maximum TSS before failing water quality standards.
[4] Turbidity was estimated from the TSS versus turbidity graph/equation in report.

$$V_{i3} = 3{,}000{,}000 - 1{,}365{,}000 = 1{,}635{,}000 \text{ yd}^3$$

*b.* Estimate the time of dredging:

$$\frac{1{,}400{,}000 \text{ yd}^3}{1{,}500 \text{ yd}^3/\text{hr}} = 933 \text{ hr}$$

Since the estimated time of dredging is 933 hr, one 27-in. dredger will be used where operating time per day is 18 hr. Thus,

$$\frac{933\ \text{hr}}{18\ \text{hr/day}} = 51.9\ \text{days}$$

(1) Average time for dredged material consolidation:

$$\frac{51.9\ \text{days}}{2} = 25.9\ \text{days}$$

(2) Design solids concentration of settled solids at 25.9 days is calculated from Equations 4-6:

$$C_{d1} = 205 \times T^{0.178}$$

$$C_{d1} = 366\ \text{g/L}$$

$$C_{d2} = 197 \times T^{0.161}$$

$$C_{d2} = 340\ \text{g/L}$$

$$C_{d3} = 211 \times T^{0.166}$$

$$C_{d3} = 411\ \text{g/L}$$

*c.* Estimate the volume required for dredged material:

(1) The average void ratio of fine-grained material for Reaches 1, 2, and 3 are calculated as follows:

$$e_o = \frac{G_s \times 1{,}000}{C_d} - 1$$

$$e_{o1} = 6.02 \qquad (7)$$

$$e_{o2} = 6.03$$

$$e_{o3} = 5.25$$

(2) The volume of the fine-grained material after disposal is calculated as follows:

$$V_f = V_i \left[ \frac{e_o - e_i}{1 + e_i} + 1 \right] \tag{8}$$

where

$V_f$ = volume of fine-grained material after disposal in CDF, $yd^3$

$V_i$ = volume of fine-grained channel sediments, $yd^3$

$e_i$ = initial void ratio in sediment

$V_{f1}$ = 1,685,134 $yd^3$

$V_{f2}$ = 1,915,626 $yd^3$

$V_{f3}$ = 3,145,287 $yd^3$

(3) The volume required for initial storage is calculated as follows:

$$V = V_f + V_{sd} \tag{9}$$

where

$V$ = total volume of dredged material in CDF, $yd^3$

$V_{sd}$ = volume of sand for Reach 1, $yd^3$

$V_1$ = 1,685,134 + 620,200
= 2,305,334 $yd^3$

$V_2$ = 1,915,626 + 774,400
= 2,690,026 $yd^3$

$V_3$ = 3,145,287 + 1,365,000
= 4,510,287 $yd^3$

*d.* Determine the maximum thickness of dredged material at end of disposal operation.

(1) The dike height is 10 ft. The allowable dredged material height is calculated as follows:

$$H_{dm(\max)} = H_{dk(\max)} - H_{pd} - H_{fb} \tag{10}$$

where

$H_{dk(max)}$ = maximum allowable dike height, ft

$H_{pd}$ = ponding depth, ft

$H_{fb}$ = freeboard (minimum of 2 ft can be assumed), ft

$$H_{dm(max)} = 10 - 2 - 2$$
$$= 6 \text{ ft}$$

(2) The minimum possible surface area is calculated as follows:

$$A_{ds} = \frac{V}{H_{dm(\max)}} \quad (11)$$

$$A_{ds1} = \frac{2{,}300{,}000 \text{ yd}^3 \times 27 \text{ ft}^3/\text{yd}^3}{6 \text{ ft}}$$

$$A_{ds1} = 10{,}350{,}000 \text{ ft}^2$$

$$A_{ds1} = 238 \text{ acres}$$

$$A_{ds2} = 278 \text{ acres}$$

$$A_{ds3} = 466 \text{ acres}$$

These are the required CDF surface areas to account for a volume of 1,400,000, 1,600,000, and 3,000,000 $yd^3$ to be dredged assuming a maximum storage height of 6 ft for Reaches 1, 2, and 3, respectively.

*e.* Determine the minimum area required for zone sedimentation.

(1) $V_{s1}$ = 0.265 ft/hr for Reach 1 (from Figure 6).

(2) The area requirement is calculated as follows:

$$A_{z1} = \frac{Q_i\ (3{,}600)}{V_{s1} \times P} \quad (12)$$

$$Q_i = 60 \text{ cfs}$$

$$A_{z1} = \frac{60 \times 3{,}600}{0.265 \times 0.5}$$

$$= 1{,}630{,}190 \text{ ft}^2 \tag{13}$$

$$A_{z1} = 37.4 \text{ acres}$$

$$A_{z2} = 45.0 \text{ acres}$$

$$A_{z3} = 64.0 \text{ acres}$$

where

$A_{z1}$ = containment surface area requirement for zone settling for Reach 1, $ft^2$

$Q_i$ = influent flow rate, cfs

3,600 = conversion factor, hr to sec

$V_{s1}$ = zone settling velocity at influent solids concentration ($C_i$) for Reach 1, ft/hr

$P$ = 50 percent of surface area ponded

(3) Increase the area by a factor of 1.87 (hydraulic efficiency correction factor (HECF)) to account for hydraulic inefficiencies (assuming the CDF can be constructed with a length-to-width ratio of approximately 3):

$$T_d / T = 0.9 \; [1 - \exp(-0.3L/W)]$$

$$= 0.53 \text{ (assumming length-to-width ratio is 3)} \tag{14}$$

and

$$T_d / T = 1/\text{HECF}$$

where

$A_{dz1}$ = design surface area for effective zone settling for Reach 1, acres

HECF = hydraulic efficiency correction factor

$T_d$ = mean residence time, hr

$T$ = theoretical residence time, hr

therefore

HECF = 1.87

$A_{dz1} = 1.87 \times 37.4$

$A_{dz1}$ = 70 acres

$A_{dz2}$ = 84 acres

$A_{dz3}$ = 120 acres

These required surface areas for zone settling are less than those evaluated for storage; therefore, the required surface areas for storage control the design.

*f.* Determine the minimum area required for ponding.

(1) The effluent suspended solids concentration was predicted as follows:

Total settling volume = 238 acres × 1,613 $yd^3$/acre-ft × 2 ft
= 767,788 $yd^3$

$T$ = 767,788 $yd^3$ ÷ 144,000 $yd^3$/day

$T_1$ = 5.3 days (128 hr)

$T_2$ = 6.2 days (149 hr)

$T_3$ = 10.4 days (251 hr)

The hydraulic efficiency factor is applied because of containment area inefficiencies (Shields, Schroeder, and Thackston 1987).

$T_{d1}$ = 128 hr ÷ 1.87

$T_{d1}$ = 68 hr

$T_{d2}$ = 80 hr

$T_{d3}$ = 134 hr

The supernatant suspended solids curve (Figures 8, 10, and 12), a retention time of 68, 80, and 134 hr, and a 2-ft ponding depth yield a suspended solids concentration of 30, 60, and 10 mg/L in the column for Reaches 1, 2, and 3, respectively. A resuspension factor of 2.0 is recommended for a ponding depth of 2 ft or greater and a surface area greater than 100 acres. The effluent suspended solids concentrations estimated for the field conditions are 75, 150, and 25 mg/L for Reaches 1, 2, and 3, respectively.

The CDF site should therefore encompass approximately 238, 278, and 466 acres of ponded surface area if the dredge selected for the project has an effective flow rate not greater than 60 cfs for Reaches 1, 2, and 3, respectively. This corresponds to the following values as previously calculated:

$H_{dm}$ = 6 ft

$H_{pd}$ = 2 ft

$H_{fd}$ = 2 ft

$A_{d1}$ = 238 acres

$A_{d2}$ = 278 acres

$A_{d3}$ = 466 acres

### Predicted effluent suspended solids concentrations

After the dredged material is placed in a CDF, solids that have not settled by gravity will remain suspended in the water column. The solids that are suspended will flow over the weir structure. The concentration of the suspended solids in the effluent is needed to determine the effectiveness of the CDF and if any water quality standards will be violated.

Prediction of the total contaminant concentrations in the effluent were made using the results of the modified elutriate test and column settling test. The total contaminant concentrations in the effluent were predicted by adding the predicted dissolved concentrations and the predicted particle-associated concentrations. The dissolved concentrations were determined directly by the modified elutriate test. The particle-associated concentrations were calculated using the contaminant fractions (Tables 4-6) of the TSS determined by the modified elutriate test and the predicted effluent suspended solids concentration determined by the column settling test. Both test results were used to predict total contaminant concentration in milligrams per liter in the effluent by using the following equation (Thackston and Palermo 1990):

$$C_{total} = C_{diss} + \frac{F_{ss} \times SS_{eff}}{(1 \times 10^6)} \tag{15}$$

$C_{total}$ = estimated total concentration in effluent, mg contaminant/L of water

$F_{ss}$ = fraction of contaminant in TSS calculated from modified elutriate test results, mg contaminant/kg of suspended solids

$(1 \times 10^6)$ = conversion factor, mg/mg to mg/kg

$C_{diss}$ = dissolved concentration determined by modified elutriate test, mg contaminant/L of sample

$SS_{eff}$ = predicted suspended solids concentration of effluent estimated from evaluation of sedimentation performance in laboratory column settling test, adjusted for field conditions by factors from Table 7 (Palermo and Thackston 1988), mg suspended solids/L of water

Tables 13-15 show the predicted total concentration of possible contaminants in the effluent. The acceptability of the proposed CDF operation can be evaluated by comparing the predicted total contaminant concentrations with applicable water quality standards. The predicted total concentrations of contaminants in the effluent were compared with Federal and/or State of Louisiana Water Quality Criteria (WQC) for surface water. All predicted effluent concentrations were below the WQC except zinc (Reach 3), which was slightly higher than the WQC; therefore, no mixing zone evaluation was required.

| Table 13 | | | |
|---|---|---|---|
| **Comparison of Predicted Effluent Quality for Reach 1** | | | |

| Parameter | Predicted Total Concentration in Effluent, mg/L | Federal Water Quality Criteria[1] | |
|---|---|---|---|
| | | Marine Acute Criteria, mg/L | Marine Chronic Criteria, mg/L |
| Beryllium | 0.0001 | – | – |
| Cadmium | 0.00001 | 0.043 | 0.0093 |
| Chromium | 0.0008 | 1.10 | 0.050 |
| Lead | 0.0004 | 0.140 | 0.0056 |
| Mercury | 0.00006 | 0.0021 | 0.000025 |
| Nickel | 0.001 | 0.075 | 0.0083 |
| Zinc | 0.0026 | 0.095 | 0.086 |
| Iron | 0.836 | – | – |

[1] U.S. Environmental Protection Agency, Office of Water Regulations and Standards, September 1986.

**Table 14**
**Comparison of Predicted Effluent Quality for Reach 2**

| Parameter | Predicted Total Concentration in Effluent, mg/L | Federal Water Quality Criteria[1] | |
|---|---|---|---|
| | | Marine Acute Criteria, mg/L | Marine Chronic Criteria, mg/L |
| Antimony | 0.00001 | – | – |
| Arsenic | 0.00008 | 0.069 | 0.036 |
| Beryllium | 0.001 | – | – |
| Cadmium | 0.000003 | 0.043 | 0.0093 |
| Chromium | 0.0016 | 1.10 | 0.050 |
| Copper | 0.001 | 0.0029 | 0.0029 |
| Lead | 0.0008 | 0.140 | 0.0056 |
| Mercury | 0.00001 | 0.0021 | 0.000025 |
| Nickel | 0.001 | 0.075 | 0.0083 |
| Selenium | 0.00002 | 0.410 | 0.054 |
| Thallium | 0.000004 | 2.13 | – |
| Zinc | 0.0026 | 0.095 | 0.086 |
| Iron | 0.836 | – | – |
| TRPH | 0.003 | – | – |

[1] U.S. Environmental Protection Agency, Office of Water Regulations and Standards, September 1986.

**Table 15**
**Comparison of Predicted Effluent Quality for Reach 3**

| Parameter | Predicted Total Concentration in Effluent, mg/L | Federal Water Quality Criteria[1] | |
|---|---|---|---|
| | | Marine Acute Criteria, mg/L | Marine Chronic Criteria, mg/L |
| Antimony | 0.0040 | – | – |
| Arsenic | 0.0027 | 0.069 | 0.036 |
| Beryllium | 0.001 | – | – |
| Cadmium | 0.00031 | 0.043 | 0.0093 |
| Chromium | 0.0008 | 1.10 | 0.050 |
| Lead | 0.0032 | 0.140 | 0.0056 |
| Mercury | 0.0002 | 0.0021 | 0.000025 |
| Nickel | 0.006 | 0.075 | 0.0083 |
| Zinc | 0.117 | 0.095 | 0.086 |
| Iron | 0.282 | – | – |

[1] U.S. Environmental Protection Agency, Office of Water Regulations and Standards, September 1986.

# 3 Conclusions and Recommendations

## Conclusions

Based on the results of the settling, modified elutriate tests, and turbidity measurements, the following is concluded:

*a.* The Calcasieu River sediments from Reaches 1, 2, and 3 exhibited zone settling with a settling rate of 0.265, 0.220, and 0.155 ft/hr for Reaches 1, 2, and 3, respectively. The zone settling behavior of the sediments indicates that 70, 84, and 120 acres of minimum surface area would be required for a CDF assuming a 27-in. dredge size.

*b.* The sediment from Reach 2 is not expected to densify to as great a solids concentration in a CDF as Reaches 1 or 3.

*c.* The removal of 1,400,000, 1,600,000, and 3,000,000 $yd^3$ of dredged material requires a CDF with a surface area of 224, 278, and 466 acres for initial storage for a dredged material storage depth of 6 ft for Reaches 1, 2, and 3, respectively.

*d.* Effluent TSS concentration for the estimated initial solids storage areas after 2.83, 3.33, and 5.58 days under quiescent settling conditions is predicted at 60, 120, and 20 mg/L, respectively. A minimum ponding surface area of 35, 42, and 60 acres is required assuming a minimum of 2-ft ponding depth for Reaches 1, 2, and 3, respectively.

*e.* The bulk chemical analyses indicate that the sediment to be dredged has detectable levels of metals in each reach. D-BHC was detected in Reaches 1 and 3. The bulk chemical analysis also indicates that the site water has slight detectable levels of metals in each reach. PPDDE was detected with an average concentration of 0.0031 mg/kg in the sediment for Reach 1. TRPH was detected with an average concentration of 53 mg/kg from Reach 3.

*f.* The modified elutriate test indicates that dissolved metals in the CDFs effluent were all below detection limits.

*g.* The modified elutriate test indicates that the total elutriate may contain particle-associated metals, such as arsenic (0.0648 mg/L), chromium (1.30 mg/L), copper (0.659 mg/L), and mercury (0.0042 mg/L) for Reach 2.

*h.* The organic analytes were less than detection limit in the modified elutriate test.

*i.* The predicted total effluent concentrations for all contaminants were calculated to be less than the Federal Marine Water Quality Criteria, indicating no need to conduct an evaluation of mixing.

*j.* The predicted total effluent concentration of zinc at 0.117 mg/L for Reach 3 was slightly higher than the fresh acute criteria (0.095 mg/L for zinc). However, the criteria could be met with minimal mixing.

*k.* The TSS for Reach 1 and Reach 2 from the modified elutriate tests were not typical of similar sediment. A possible explanation is that little to no interface developed after 24 hr of settling, resulting in an elevated level of TSS.

*l.* The turbidity-TSS correlation curves for Reaches 1, 2, and 3 were developed. It appears that TSS may be estimated from each appropriate curve.

## Recommendations

Based on the results of this study, it is recommended that the settling test from Reaches 1, 2, and 3 and the modified elutriate test results from Reach 3 be utilized for the proper design of each CDF to store the Calcasieu River dredged materials. Based on results of the turbidity and TSS correlation curves, it is recommended that they be utilized to monitor operations as an indication of TSS for each reach. It is also recommended that the maximum effluent TSS from Reach 3 (Table 12) be utilized to monitor the critical contaminates, zinc (Reaches 1 and 3) and copper (Reach 2).

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# Appendix A
# Detailed Test Results

**Table A1**
**Bulk Chemistry Analysis of Composite Sediment from Reach 1**

| Analyte | Concentrations, mg/kg | | | |
|---|---|---|---|---|
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Phenol | <1.4 | <1.4 | <1.4 | <1.4 |
| 2-Chlorophenol | <1.4 | <1.4 | <1.4 | <1.4 |
| 2-Nitrophenol | <1.4 | <1.4 | <1.4 | <1.4 |
| 2,4-Dimethylphenol | <1.4 | <1.4 | <1.4 | <1.4 |
| 2,4-Dichlorophenol | <1.4 | <1.4 | <1.4 | <1.4 |
| 4-Chloro-3-Methylphenol | <2.8 | <2.8 | <2.8 | <2.8 |
| 2,4,6-Trichlorophenol | <1.4 | <1.4 | <1.4 | <1.4 |
| 2,4-Dinitrophenol | <7.0 | <7.0 | <7.0 | <7.0 |
| 4-Nitrophenol | <7.0 | <7.0 | <7.0 | <7.0 |
| 2-Methyl-4,6-Dinotrophenol | <7.0 | <7.0 | <7.0 | <7.0 |
| Pentachlorophenol | <7.0 | <7.0 | <7.0 | <7.0 |
| Benzoic Acid | <7.0 | <7.0 | <7.0 | <7.0 |
| 2-Methylphenol | <1.4 | <1.4 | <1.4 | <1.4 |
| 4-Methylphenol | <1.4 | <1.4 | <1.4 | <1.4 |
| 2,4,5-Trichlorophenol | <1.4 | <1.4 | <1.4 | <1.4 |
| Benzyl Alcohol | <2.8 | <2.8 | <2.8 | <2.8 |
| N-Nitrosodimethylamine | <1.4 | <1.4 | <1.4 | <1.4 |
| Bis(2-Chloroisopropyl)Ether | <1.4 | <1.4 | <1.4 | <1.4 |
| N-Nitroso-Di-N-Propylamine | <1.4 | <1.4 | <1.4 | <1.4 |
| Nitrobenzene | <1.4 | <1.4 | <1.4 | <1.4 |
| Isophorone | <1.4 | <1.4 | <1.4 | <1.4 |
| Bis(2-Chloroethoxy)Methane | <1.4 | <1.4 | <1.4 | <1.4 |
| 2,6-Dinitrotoluene | <1.4 | <1.4 | <1.4 | <1.4 |
| 2,4-Dinitrotoluene | <1.4 | <1.4 | <1.4 | <1.4 |
| 1,2-Diphenylhydrazine | <1.4 | <1.4 | <1.4 | <1.4 |
| Benzidine | <7.0 | <7.0 | <7.0 | <7.0 |
| 3,3'Dichlorobenzidine | <2.8 | <2.8 | <2.8 | <2.8 |
| Bis(2-Chloroetnyl)Ether | <1.4 | <1.4 | <1.4 | <1.4 |
| 1,3-Dichlorobenzene | <1.4 | <1.4 | <1.4 | <1.4 |
| 1,4-Dichlorobenzene | <1.4 | <1.4 | <1.4 | <1.4 |
| 1,2-Dichlorobenzene | <1.4 | <1.4 | <1.4 | <1.4 |
| Hexachloroethane | <1.4 | <1.4 | <1.4 | <1.4 |
| 1,2,4-Trichlorobenzene | <1.4 | <1.4 | <1.4 | <1.4 |
| Naphthalene | <1.4 | <1.4 | <1.4 | <1.4 |
| Hexachlorobutadiene | <1.4 | <1.4 | <1.4 | <1.4 |
| Hexachlorocyclopentadiene | <1.4 | <1.4 | <1.4 | <1.4 |

*(Sheet 1 of 6)*

Note: B - Indicates analyte is found in the associated blank as well as in the sample.
J - Indicates an estimated value below instrument detection limit.

| Table A1 (Continued) | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/kg** | | | |
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| 2-Chloronaphthalene | <1.4 | <1.4 | <1.4 | <1.4 |
| Acenaphthylene | <1.4 | <1.4 | <1.4 | <1.4 |
| Dimethyl Phthalate | <1.4 | <1.4 | <1.4 | <1.4 |
| Acenaphthene | <1.4 | <1.4 | <1.4 | <1.4 |
| Fluorene | <1.4 | <1.4 | <1.4 | <1.4 |
| Diethyl Phthalate | <1.4 | <1.4 | <1.4 | <1.4 |
| 4-Chlorophenyl Phenyl Ether | <1.4 | <1.4 | <1.4 | <1.4 |
| N-Nitrosodiphenyl Amine | <1.4 | <1.4 | <1.4 | <1.4 |
| 4-Bromophenyl Ether | <1.4 | <1.4 | <1.4 | <1.4 |
| Hexachlorobenzene | <1.4 | <1.4 | <1.4 | <1.4 |
| Phenanthrene | <1.4 | 0.04J | <1.4 | <1.4 |
| Anthracene | <1.4 | <1.4 | <1.4 | <1.4 |
| Dibutylphthalate | 6.9B | 0.04BJ | 0.80BJ | 2.6B |
| Fluoranthene | 0.07J | 0.12J | 0.07J | 0.09J |
| Pyrene | 0.06J | 0.12J | 0.07J | 0.08J |
| Butylbenzylphthalate | <1.4 | <1.4 | <1.4 | <1.4 |
| Chrysene | <1.4 | 0.07J | 0.04J | 0.50J |
| Benzo(a)Anthracene | <1.4 | <1.4 | <1.4 | <1.4 |
| Bis(2-Ethylhexyl)Phthalate | 0.07BJ | 0.10BJ | 0.07BJ | 0.08BJ |
| Di-N-Octylphthalate | <1.4 | <1.4 | <1.4 | <1.4 |
| Benzo(b)Fluoranthene | <1.4 | <1.4 | <1.4 | <1.4 |
| Benzo(k)Fluoranthene | <1.4 | <1.4 | <1.4 | <1.4 |
| Benzo(a)Pyrene | <1.4 | <1.4 | <1.4 | <1.4 |
| Indeno(1,2,3-C,D)Pyrene | <1.4 | <1.4 | <1.4 | <1.4 |
| Dibenzo(A,H)Anthracene | <1.4 | <1.4 | <1.4 | <1.4 |
| Benzo(G,H,I)Perylene | <1.4 | <1.4 | <1.4 | <1.4 |
| Aniline | <2.8 | <2.8 | <2.8 | <2.8 |
| 4-Chloroaniline | <2.8 | <2.8 | <2.8 | <2.8 |
| Dibenzofuran | <1.4 | <1.4 | <1.4 | <1.4 |
| 2-Methylnaphthalene | <1.4 | <1.4 | <1.4 | <1.4 |
| 2-Nitroaniline | <7.0 | <7.0 | <7.0 | <7.0 |
| 3-Nitroaniline | <7.0 | <7.0 | <7.0 | <7.0 |
| 4-Nitroaniline | <7.0 | <7.0 | <7.0 | <7.0 |
| Perylene | 0.03J | 0.04J | 0.03J | 0.03J |
| | | | | *(Sheet 2 of 6)* |

| **Table A1 (Continued)** | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/kg** | | | |
| **Pesticides/PCBs** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Aldrin | <0.0027 | <0.0027 | <0.0027 | <0.0027 |
| A-BHC | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| B-BHC | <0.0041 | <0.0041 | <0.0041 | <0.0041 |
| G-BHC | <0.0027 | <0.0027 | <0.0027 | <0.0027 |
| D-BHC | 0.019 | 0.011 | 0.026 | 0.019 |
| PPDDD | <0.0074 | <0.0074 | <0.0074 | <0.0074 |
| PPDDE | 0.0038 | <0.0027 | <0.0027 | 0.0031 |
| PPDDT | <0.0081 | <0.0081 | <0.0081 | <0.0081 |
| Heptachlor | <0.0020 | 0.0011J | <0.0020 | 0.0017J |
| Dieldrin | <0.0014 | <0.0014 | <0.0014 | <0.0014 |
| A-Endosulfan | <0.0094 | <0.0094 | <0.0094 | <0.0094 |
| B-Endosulfan | <0.0027 | <0.0027 | <0.0027 | <0.0027 |
| Endosulfan sulfate | <0.045 | <0.045 | <0.045 | <0.045 |
| Endrin | <0.0041 | <0.0041 | <0.0041 | <0.0041 |
| Endrin Aldehyde | <0.016 | <0.016 | <0.016 | <0.016 |
| Heptachlor Epoxide | <0.055 | <0.055 | <0.055 | <0.055 |
| Methoxychlor | <0.12 | <0.12 | <0.12 | <0.12 |
| Chlordane | <0.0094 | <0.0094 | <0.0094 | <0.0094 |
| Toxaphene | <0.16 | <0.16 | <0.16 | <0.16 |
| PCB-1016 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1221 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1232 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1242 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1248 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1254 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1260 | <0.041 | <0.041 | <0.041 | <0.041 |
| **Other Organics** | | | | |
| Total Organic Carbon | 15,516 | 16,775 | 15,763 | 16,018 |
| Total Recoverable Petroleum Hydrocarbons | <25 | <25 | <25 | <25 |
| | | | | *(Sheet 3 of 6)* |

| Table A1 (Continued) | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/kg** | | | |
| **Metals** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Antimony | <0.30 | <0.30 | <0.30 | <0.30 |
| Arsenic | 2.37 | 2.23 | 2.22 | 2.27 |
| Beryllium | 0.999 | 1.00 | 1.00 | 1.00 |
| Cadmium | 0.200 | 0.272 | 0.161 | 0.211 |
| Chromium | 9.75 | 9.20 | 9.10 | 9.35 |
| Copper | 8.24 | 7.90 | 7.90 | 8.01 |
| Lead | 22.4 | 23.9 | 13.7 | 20.0 |
| Mercury | <0.100 | <0.100 | <0.100 | <0.100 |
| Nickel | 7.39 | 7.20 | 6.60 | 7.06 |
| Selenium | 0.51 | 0.47 | 0.47 | 0.48 |
| Silver | <1.00 | <1.00 | <1.00 | <1.00 |
| Thallium | <0.20 | <0.20 | <0.20 | <0.20 |
| Zinc | 40.7 | 32.5 | 25.1 | 32.8 |
| Iron | 8,225 | 7,460 | 7,380 | 7,688 |
| | | | | *(Sheet 4 of 6)* |

**Table A1 (Continued)**

| Volatiles | Individual Sample Concentration, mg/kg | | | | | |
|---|---|---|---|---|---|---|
| | CR-1 | CR-2 | CR-3 | CR-4 | CR-5 | CR-6 |
| Chloromethane | <0.015 | <0.013 | <0.022 | <0.013 | <0.032 | <0.017 |
| Bromomethane | <0.015 | <0.013 | <0.022 | <0.013 | <0.032 | <0.017 |
| Vinyl Chloride | <0.015 | <0.013 | <0.022 | <0.013 | <0.032 | <0.017 |
| Chloroethane | <0.015 | <0.013 | <0.022 | <0.013 | <0.032 | <0.017 |
| Methylene Chloride | 0.067B | 0.063B | 0.10B | 0.025B | 0.024B | 0.010B |
| 1,1-Dichloroethene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| 1,1-Dichloroethane | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Trans-1,2-Dichloroethene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| cis-1,2-Dichloroethene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Chloroform | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| 1,2-Dichloroethane | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| 1,1,1-Trichloroethane | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Carbon Tetrachloride | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Bromodichloromethane | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| 1,2-Dichloropropane | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Trans-1,3-Dichloropropene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Trichloroethene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Dibromochloromethane | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| cis-1,3-Dichloropropene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| 1,1,2-Trichloroethane | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Benzene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Bromoform | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| 1,1,2,2-Tetrachloroethane | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Tetrachloroethene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Toluene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Chlorobenzene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Ethylbenzene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Acetone | 0.17B | 0.067BJ | 0.087BJ | 0.035BJ | 0.25BJ | 0.084BJ |
| 2-Butanone | <0.15 | <0.13 | <0.22 | <0.13 | 0.068J | <0.17 |
| Carbondisulfide | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| 2-Hexanone | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| 4-Methyl-2-Pentanone | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Styrene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| Vinyl Acetate | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |
| T-Xylene | <0.0075 | <0.0065 | <0.011 | <0.0065 | <0.016 | <0.0085 |

*(Sheet 5 of 6)*

| Table A1 (Concluded) | | | |
|---|---|---|---|
| | Individual Sample Concentration mg/kg | | |
| **Volatiles** | **CR-7** | **CR-29** | **CR-30** |
| Chloromethane | <0.026 | <0.017 | <0.013 |
| Bromomethane | <0.026 | <0.017 | <0.013 |
| Vinyl Chloride | <0.026 | <0.013 | <0.013 |
| Chloroethane | <0.026 | <0.017 | <0.013 |
| Methylene Chloride | 0.021B | 0.0069B | 0.028B |
| 1,1-Dichloroethene | <0.013 | <0.0085 | <0.0065 |
| 1,1-Dichloroethane | <0.013 | <0.0085 | <0.0065 |
| Trans-1,2-Dichloroethene | <0.013 | <0.0085 | <0.0065 |
| cis-1,2-Dichloroethene | <0.013 | <0.0085 | <0.0065 |
| Chloroform | <0.013 | <0.0085 | <0.0065 |
| 1,2-Dichloroethane | <0.013 | <0.0085 | <0.0065 |
| 1,1,1-Trichloroethane | <0.013 | <0.0085 | <0.0065 |
| Carbon Tetrachloride | <0.013 | <0.0085 | <0.0065 |
| Bromodichloromethane | <0.013 | <0.0085 | <0.0065 |
| 1,2-Dichloropropane | <0.013 | <0.0085 | <0.0065 |
| Trans-1,3-Dichloropropene | <0.013 | <0.0085 | <0.0065 |
| Trichloroethene | <0.013 | <0.0085 | <0.0065 |
| Dibromochloromethane | <0.013 | <0.0085 | <0.0065 |
| cis-1,3-Dichloropropene | <0.013 | <0.0085 | <0.0065 |
| 1,1,2-Trichloroethane | <0.013 | <0.0085 | <0.0065 |
| Benzene | <0.013 | <0.0085 | <0.0065 |
| Bromoform | <0.013 | <0.0085 | <0.0065 |
| 1,1,2,2-Tetrachloroethane | <0.013 | <0.0085 | <0.0065 |
| Tetrachloroethene | <0.013 | <0.0085 | <0.0065 |
| Toluene | <0.013 | <0.0085 | <0.0065 |
| Chlorobenzene | <0.013 | <0.0085 | <0.0065 |
| Ethylbenzene | <0.013 | <0.0085 | <0.0065 |
| Acetone | 0.14BJ | 0.045BJ | 0.055BJ |
| 2-Butanone | <0.26 | <0.17 | <0.13 |
| Carbondisulfide | <0.013 | <0.0085 | <0.0065 |
| 2-Hexanone | <0.013 | <0.0085 | <0.0065 |
| 4-Methyl-2-Pentanone | <0.013 | <0.0085 | <0.0065 |
| Styrene | <0.013 | <0.0085 | <0.0065 |
| Vinyl Acetate | <0.013 | <0.0085 | <0.0065 |
| T-Xylene | <0.013 | <0.0085 | <0.0065 |
| | | | *(Sheet 6 of 6)* |

**Table A2**
**Bulk Chemistry Analysis for Reach 1 Site Water**

| Analyte | Concentration, mg/L | | |
|---|---|---|---|
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Average** |
| Phenol | <0.010 | <0.015 | <0.013 |
| 2-Chlorophenol | <0.010 | <0.015 | <0.013 |
| 2-Nitrophenol | <0.010 | <0.015 | <0.013 |
| 2,4-Dimethylphenol | <0.010 | <0.015 | <0.013 |
| 2,4-Dichlorophenol | <0.010 | <0.015 | <0.013 |
| 4-Chloro-3-Methylphenol | <0.020 | <0.030 | <0.025 |
| 2,4,6-Trichlorophenol | <0.010 | <0.015 | <0.013 |
| 2,4-Dinitrophenol | <0.050 | <0.075 | <0.063 |
| 4-Nitrophenol | <0.050 | <0.075 | <0.063 |
| 2-Methyl-4,6-Dinotrophenol | <0.050 | <0.075 | <0.063 |
| Pentachlorophenol | <0.050 | <0.075 | <0.063 |
| Benzoic Acid | <0.050 | <0.075 | <0.063 |
| 2-Methylphenol | <0.010 | <0.015 | <0.013 |
| 4-Methylphenol | <0.010 | <0.015 | <0.013 |
| 2,4,5-Trichlorophenol | <0.010 | <0.015 | <0.013 |
| Benzyl Alcohol | <0.020 | <0.030 | <0.025 |
| N-Nitrosodimethylamine | <0.010 | <0.015 | <0.013 |
| Bis(2-Chloroisopropyl)Ether | <0.010 | <0.015 | <0.013 |
| N-Nitroso-Di-N-Propylamine | <0.010 | <0.015 | <0.013 |
| Nitrobenzene | <0.010 | <0.015 | <0.013 |
| Isophorone | <0.010 | <0.015 | <0.013 |
| Bis(2-Chloroethoxy)Methane | <0.010 | <0.015 | <0.013 |
| 2,6-Dinitrotoluene | <0.010 | <0.015 | <0.013 |
| 2,4-Dinitrotoluene | <0.010 | <0.015 | <0.013 |
| 1,2-Diphenylhydrazine | <0.010 | <0.015 | <0.013 |
| Benzidine | <0.050 | <0.075 | <0.063 |
| 3,3'Dichlorobenzidine | <0.020 | <0.030 | <0.025 |
| Bis(2-Chloroethyl)Ether | <0.010 | <0.015 | <0.013 |
| 1,3-Dichlorobenzene | <0.010 | <0.015 | <0.013 |
| 1,4-Dichlorobenzene | <0.010 | <0.015 | <0.013 |
| 1,2-Dichlorobenzene | <0.010 | <0.015 | <0.013 |
| Hexachloroethane | <0.010 | <0.015 | <0.013 |
| 1,2,4-Trichlorobenzene | <0.010 | <0.015 | <0.013 |
| Naphthalene | <0.010 | <0.015 | <0.013 |
| Hexachlorobutadiene | <0.010 | <0.015 | <0.013 |
| Hexachlorocyclopentadiene | <0.010 | <0.015 | <0.013 |

*(Sheet 1 of 5)*

| Table A2 (Continued) | | | |
|---|---|---|---|
| **Analyte** | **Concentration, mg/L** | | |
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Average** |
| 2-Chloronaphthalene | <0.010 | <0.015 | <0.013 |
| Acenaphthylene | <0.010 | <0.015 | <0.013 |
| Dimethyl Phthalate | <0.010 | <0.015 | <0.013 |
| Acenaphthene | <0.010 | <0.015 | <0.013 |
| Fluorene | <0.010 | <0.015 | <0.013 |
| Diethyl Phthalate | <0.010 | <0.015 | <0.013 |
| 4-Chlorophenyl Phenyl Ether | <0.010 | <0.015 | <0.013 |
| N-Nitrosodiphenyl Amine | <0.010 | <0.015 | <0.013 |
| 4-Bromophenyl Ether | <0.010 | <0.015 | <0.013 |
| Hexachlorobenzene | <0.010 | <0.015 | <0.013 |
| Phenanthrene | <0.010 | <0.015 | <0.013 |
| Anthracene | <0.010 | <0.015 | <0.013 |
| Dibutylphthalate | <0.010 | <0.015 | <0.013 |
| Fluoranthene | <0.010 | <0.015 | <0.013 |
| Pyrene | <0.010 | <0.015 | <0.013 |
| Butylbenzylphthalate | <0.010 | <0.015 | <0.013 |
| Chrysene | <0.010 | <0.015 | <0.013 |
| Benzo(a)Anthracene | <0.010 | <0.015 | <0.013 |
| Bis(2-Ethylhexyl)Phthalate | 0.0011J | <0.015 | 0.0081J |
| Di-N-Octylphthalate | <0.010 | <0.015 | <0.013 |
| Benzo(b)Fluoranthene | <0.010 | <0.015 | <0.013 |
| Benzo(k)Fluoranthene | <0.010 | <0.015 | <0.013 |
| Benzo(a)Pyrene | <0.010 | <0.015 | <0.013 |
| Indeno(1,2,3-C,D)Pyrene | <0.010 | <0.015 | <0.013 |
| Dibenzo(A,H)Anthracene | <0.010 | <0.015 | <0.013 |
| Benzo(G,H,I)Perylene | <0.010 | <0.015 | <0.013 |
| Aniline | <0.020 | <0.030 | <0.025 |
| 4-Chloroaniline | <0.020 | <0.030 | <0.025 |
| Dibenzofuran | <0.010 | <0.015 | <0.013 |
| 2-Methylnaphthalene | <0.010 | <0.015 | <0.013 |
| 2-Nitroaniline | <0.050 | <0.075 | <0.063 |
| 3-Nitroaniline | <0.050 | <0.075 | <0.063 |
| 4-Nitroaniline | <0.050 | <0.075 | <0.063 |

*(Sheet 2 of 5)*

## Table A2 (Continued)

| Analyte | Concentration, mg/L | | |
|---|---|---|---|
| **Pesticides/PCBs** | **Replicate 1** | **Replicate 2** | **Average** |
| Aldrin | <0.000042 | <0.000089 | <0.000066 |
| A-BHC | <0.000031 | <0.000067 | <0.000049 |
| B-BHC | <0.000062 | <0.00013 | <0.000096 |
| G-BHC | <0.000042 | <0.000089 | <0.000066 |
| D-BHC | <0.000094 | <0.00020 | <0.00015 |
| PPDDD | <0.00011 | <0.00024 | <0.00018 |
| PPDDE | <0.000042 | <0.000089 | <0.000066 |
| PPDDT | <0.00012 | <0.00027 | <0.00020 |
| Heptachlor | <0.000031 | <0.000067 | <0.000049 |
| Dieldrin | <0.000021 | <0.000044 | <0.000033 |
| A-Endosulfan | <0.00014 | <0.00031 | <0.00023 |
| B-Endosulfan | <0.000042 | <0.000089 | <0.000066 |
| Endosulfan sulfate | <0.00069 | <0.0015 | <0.0011 |
| Endrin | <0.000062 | <0.00013 | <0.00010 |
| Endrin Aldehyde | <0.00024 | <0.00051 | <0.00038 |
| Heptachlor Epoxide | <0.00086 | <0.0018 | <0.0013 |
| Methoxychlor | <0.0019 | <0.0040 | <0.0030 |
| Chlordane | <0.00014 | <0.00031 | <0.00023 |
| Toxaphene | <0.0025 | <0.0053 | <0.0039 |
| PCB-1016 | <0.00063 | <0.0013 | <0.0010 |
| PCB-1221 | <0.00063 | <0.0013 | <0.0010 |
| PCB-1232 | <0.00063 | <0.0013 | <0.0010 |
| PCB-1242 | <0.00063 | <0.0013 | <0.0010 |
| PCB-1248 | <0.00063 | <0.0013 | <0.0010 |
| PCB-1254 | <0.00063 | <0.0013 | <0.0010 |
| PCB-1260 | <0.00063 | <0.0013 | <0.0010 |
| **Other Organics** | | | |
| Total Organic Carbon | 12.2 | 8.9 | 10.6 |
| Total Recoverable Petroleum Hydrocarbons | <0.5 | <0.5 | <0.5 |
| | | | ***(Sheet 3 of 5)*** |

| Table A2 (Continued) | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/L** | | | |
| **Metals** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Antimony | <0.0030 | <0.0030 | <0.0030 | <0.0030 |
| Arsenic | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Beryllium | <0.001 | <0.001 | <0.001 | <0.001 |
| Cadmium | <0.00020 | 0.00046 | 0.00038 | 0.00035 |
| Chromium | <0.005 | <0.005 | <0.005 | <0.005 |
| Copper | <0.001 | <0.001 | <0.001 | <0.001 |
| Lead | <0.0010 | 0.0046 | 0.0040 | 0.0032 |
| Mercury | <0.0002 | <0.0002 | <0.0002 | <0.0002 |
| Nickel | <0.005 | <0.005 | <0.005 | <0.005 |
| Selenium | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Silver | <0.010 | <0.010 | <0.010 | <0.010 |
| Thallium | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Zinc | 0.017 | 0.172 | 0.137 | 0.109 |
| Iron | 0.701 | 0.757 | 0.710 | 0.723 |
| | | | | *(Sheet 4 of 5)* |

## Table A2 (Concluded)

| Volatiles | Concentration, mg/L | | |
|---|---|---|---|
| | Reach 1 | Reach 2 | Reach 3 |
| Chloromethane | <0.010 | <0.010 | <0.010 |
| Bromomethane | <0.010 | <0.010 | <0.010 |
| Vinyl Chloride | <0.010 | <0.010 | <0.010 |
| Chloroethane | <0.010 | <0.010 | <0.010 |
| Methylene Chloride | 0.013B | 0.0062B | 0.0060B |
| 1,1-Dichloroethene | <0.0050 | <0.0050 | <0.0050 |
| 1,1-Dichloroethane | <0.0050 | <0.0050 | <0.0050 |
| Trans-1,2-Dichloroethene | <0.0050 | <0.0050 | <0.0050 |
| cis-1,2-Dichloroethene | <0.0050 | <0.0050 | <0.0050 |
| Chloroform | <0.0050 | <0.0050 | <0.0050 |
| 1,2-Dichloroethane | <0.0050 | 0.00064J | 0.00070J |
| 1,1,1-Trichloroethane | <0.0050 | <0.0050 | <0.0050 |
| Carbon Tetrachloride | <0.0050 | <0.0050 | <0.0050 |
| Bromodichloromethane | <0.0050 | <0.0050 | <0.0050 |
| 1,2-Dichloropropane | <0.0050 | <0.0050 | <0.0050 |
| Trans-1,3-Dichloropropene | <0.0050 | <0.0050 | <0.0050 |
| Trichloroethene | <0.0050 | <0.0050 | <0.0050 |
| Dibromochloromethane | <0.0050 | <0.0050 | <0.0050 |
| cis-1,3-Dichloropropene | <0.0050 | <0.0050 | <0.0050 |
| 1,1,2-Trichloroethane | <0.0050 | <0.0050 | <0.0050 |
| Benzene | <0.0050 | <0.0050 | <0.0050 |
| Bromoform | <0.0050 | <0.0050 | <0.0050 |
| 1,1,2,2-Tetrachloroethane | <0.0050 | <0.0050 | <0.0050 |
| Tetrachloroethene | <0.0050 | <0.0050 | <0.0050 |
| Toluene | <0.0050 | <0.0050 | <0.0050 |
| Chlorobenzene | <0.0050 | <0.0050 | <0.0050 |
| Ethylbenzene | <0.0050 | <0.0050 | <0.0050 |
| Acetone | <0.10 | <0.10 | <0.10 |
| 2-Butanone | <0.10 | <0.10 | <0.10 |
| Carbondisulfide | <0.0050 | <0.0050 | <0.0050 |
| 2-Hexanone | <0.050 | <0.050 | <0.050 |
| 4-Methyl-2-Pentanone | <0.050 | <0.050 | <0.050 |
| Styrene | <0.0050 | <0.0050 | <0.0050 |
| Vinyl Acetate | <0.050 | <0.050 | <0.050 |
| T-Xylene | <0.0050 | <0.0050 | <0.0050 |

*(Sheet 5 of 5)*

**Table A3**
**Bulk Chemistry Analysis of Composite Sediment from Reach 2**

| Analyte | Concentration, mg/kg | | | |
|---|---|---|---|---|
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Phenol | <1.5 | <1.4 | <1.4 | <1.4 |
| 2-Chlorophenol | <1.5 | <1.4 | <1.4 | <1.4 |
| 2-Nitrophenol | <1.5 | <1.4 | <1.4 | <1.4 |
| 2,4-Dimethylphenol | <1.5 | <1.4 | <1.4 | <1.4 |
| 2,4-Dichlorophenol | <1.5 | <1.4 | <1.4 | <1.4 |
| 4-Chloro-3-Methylphenol | <3.0 | <2.8 | <2.8 | <2.8 |
| 2,4,6-Trichlorophenol | <1.5 | <1.4 | <1.4 | <1.4 |
| 2,4-Dinitrophenol | <7.5 | <7.0 | <7.0 | <7.0 |
| 4-Nitrophenol | <7.5 | <7.0 | <7.0 | <7.0 |
| 2-Methyl-4,6-Dinotrophenol | <7.5 | <7.0 | <7.0 | <7.0 |
| Pentachlorophenol | <7.5 | <7.0 | <7.0 | <7.0 |
| Benzoic Acid | <7.5 | <7.0 | <7.0 | <7.0 |
| 2-Methylphenol | <1.5 | <1.4 | <1.4 | <1.4 |
| 4-Methylphenol | <1.5 | <1.4 | <1.4 | <1.4 |
| 2,4,5-Trichlorophenol | <1.5 | <1.4 | <1.4 | <1.4 |
| Benzyl Alcohol | <3.0 | <2.8 | <2.8 | <2.8 |
| N-Nitrosodimethylamine | <1.5 | <1.4 | <1.4 | <1.4 |
| Bis(2-Chloroisopropyl)Ether | <1.5 | <1.4 | <1.4 | <1.4 |
| N-Nitroso-Di-N-Propylamine | <1.5 | <1.4 | <1.4 | <1.4 |
| Nitrobenzene | <1.5 | <1.4 | <1.4 | <1.4 |
| Isophorone | <1.5 | <1.4 | <1.4 | <1.4 |
| Bis(2-Chloroethoxy)Methane | <1.5 | <1.4 | <1.4 | <1.4 |
| 2,6-Dinitrotoluene | <1.5 | <1.4 | <1.4 | <1.4 |
| 2,4-Dinitrotoluene | <1.5 | <1.4 | <1.4 | <1.4 |
| 1,2-Diphenylhydrazine | <1.5 | <1.4 | <1.4 | <1.4 |
| Benzidine | <7.5 | <7.0 | <7.0 | <7.0 |
| 3,3'Dichlorobenzidine | <3.0 | <2.8 | <2.8 | <2.8 |
| Bis(2-Chloroethyl)Ether | <1.5 | <1.4 | <1.4 | <1.4 |
| 1,3-Dichlorobenzene | <1.5 | <1.4 | <1.4 | <1.4 |
| 1,4-Dichlorobenzene | <1.5 | <1.4 | <1.4 | <1.4 |
| 1,2-Dichlorobenzene | <1.5 | <1.4 | <1.4 | <1.4 |
| Hexachloroethane | <1.5 | <1.4 | <1.4 | <1.4 |
| 1,2,4-Trichlorobenzene | <1.5 | <1.4 | <1.4 | <1.4 |
| Naphthalene | <1.5 | <1.4 | <1.4 | <1.4 |
| Hexachlorobutadiene | <1.5 | <1.4 | <1.4 | <1.4 |
| Hexachlorocyclopentadiene | <1.5 | <1.4 | <1.4 | <1.4 |

*(Sheet 1 of 5)*

| Table A3 (Continued) | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/kg** | | | |
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| 2-Chloronaphthalene | <1.5 | <1.4 | <1.4 | <1.4 |
| Acenaphthylene | <1.5 | <1.4 | <1.4 | <1.4 |
| Dimethyl Phthalate | <1.5 | <1.4 | <1.4 | <1.4 |
| Acenaphthene | <1.5 | <1.4 | <1.4 | <1.4 |
| Fluorene | <1.5 | <1.4 | <1.4 | <1.4 |
| Diethyl Phthalate | 0.07J | <1.4 | <1.4 | 0.96J |
| 4-Chlorophenyl Phenyl Ether | <1.5 | <1.4 | <1.4 | <1.4 |
| N-Nitrosodiphenyl Amine | <1.5 | <1.4 | <1.4 | <1.4 |
| 4-Bromophenyl Ether | <1.5 | <1.4 | <1.4 | <1.4 |
| Hexachlorobenzene | <0.07J | <1.4 | <1.4 | 0.96J |
| Phenanthrene | <1.5 | 0.04J | <1.4 | 0.98J |
| Anthracene | <1.5 | <1.4 | <1.4 | <1.4 |
| Dibutylphthalate | 0.66BJ | 0.28BJ | 3.1B | 1.3BJ |
| Fluoranthene | <1.5 | 0.05J | <1.4 | 0.98J |
| Pyrene | <1.5 | 0.07J | 0.04J | 0.54J |
| Butylbenzylphthalate | <1.5 | <1.4 | <1.4 | <1.4 |
| Chrysene | <1.5 | <1.4 | <1.4 | <1.4 |
| Benzo(a)Anthracene | <1.5 | <1.4 | <1.4 | <1.4 |
| Bis(2-Ethylhexyl)Phthalate | 0.14BJ | 0.22BJ | 0.09BJ | 0.15BJ |
| Di-N-Octylphthalate | <1.5 | <1.4 | <1.4 | <1.4 |
| Benzo(b)Fluoranthene | <1.5 | <1.4 | <1.4 | <1.4 |
| Benzo(k)Fluoranthene | <1.5 | <1.4 | <1.4 | <1.4 |
| Benzo(a)Pyrene | <1.5 | <1.4 | <1.4 | <1.4 |
| Indeno(1,2,3-C,D)Pyrene | <1.5 | <1.4 | <1.4 | <1.4 |
| Dibenzo(A,H)Anthracene | <1.5 | <1.4 | <1.4 | <1.4 |
| Benzo(G,H,I)Perylene | <1.5 | <1.4 | <1.4 | <1.4 |
| Aniline | <3.0 | <2.8 | <2.8 | <2.8 |
| 4-Chloroaniline | <3.0 | <2.8 | <2.8 | <2.8 |
| Dibenzofuran | <1.5 | <1.4 | <1.4 | <1.4 |
| 2-Methylnaphthalene | <1.5 | <1.4 | <1.4 | <1.4 |
| 2-Nitroaniline | <7.5 | <7.0 | <7.0 | <7.0 |
| 3-Nitroaniline | <7.5 | <7.0 | <7.0 | <7.0 |
| 4-Nitroaniline | <7.5 | <7.0 | <7.0 | <7.0 |
| Perylene | <1.4 | 0.04J | <1.4 | 0.95J |
| | | | | *(Sheet 2 of 5)* |

| Table A3 (Continued) | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/kg** | | | |
| **Pesticides/PCBs** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Aldrin | <0.0027 | <0.0027 | <0.0027 | <0.0027 |
| A-BHC | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| B-BHC | <0.0041 | <0.0041 | <0.0041 | <0.0041 |
| G-BHC | <0.0027 | <0.0027 | <0.0027 | <0.0027 |
| D-BHC | <0.00061 | <0.00061 | <0.00061 | <0.00061 |
| PPDDD | <0.0074 | <0.0074 | <0.0074 | <0.0074 |
| PPDDE | <0.0027 | <0.0027 | <0.0027 | <0.0027 |
| PPDDT | <0.0081 | <0.0081 | <0.0081 | <0.0081 |
| Heptachlor | 0.0017J | 0.0016J | 0.0016J | 0.0017J |
| Dieldrin | 0.0010J | <0.0014 | <0.0014 | 0.0013J |
| A-Endosulfan | <0.0094 | <0.0094 | <0.0094 | <0.0094 |
| B-Endosulfan | <0.0027 | <0.0027 | <0.0027 | <0.0027 |
| Endosulfan sulfate | <0.045 | <0.045 | <0.045 | <0.045 |
| Endrin | <0.0041 | <0.0041 | <0.0041 | <0.0041 |
| Endrin Aldehyde | <0.016 | <0.016 | <0.016 | <0.016 |
| Heptachlor Epoxide | 0.0051J | 0.0053J | 0.0066J | 0.0057J |
| Methoxychlor | <0.12 | <0.12 | <0.12 | <0.12 |
| Chlordane | <0.0094 | <0.0094 | <0.0094 | <0.0094 |
| Toxaphene | <0.16 | <0.16 | <0.16 | <0.16 |
| PCB-1016 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1221 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1232 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1242 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1248 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1254 | <0.041 | <0.041 | <0.041 | <0.041 |
| PCB-1260 | <0.041 | <0.041 | <0.041 | <0.041 |
| **Other Organics** | | | | |
| Total Organic Carbon | 17,108 | 22,545 | 18,339 | 19,331 |
| Total Recoverable Petroleum Hydrocarbons | <25 | <25 | <25 | <25 |
| | | | | *(Sheet 3 of 5)* |

| Table A3 (Continued) | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/kg** | | | |
| **Metals** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Antimony | <0.30 | <0.30 | <0.30 | <0.30 |
| Arsenic | 1.78 | 1.99 | 1.94 | 1.90 |
| Beryllium | 0.800 | 0.899 | 0.900 | 0.866 |
| Cadmium | 0.079 | 0.081 | 0.254 | 0.138 |
| Chromium | 7.60 | 8.69 | 7.00 | 7.76 |
| Copper | 6.80 | 6.69 | 6.30 | 6.60 |
| Lead | 12.3 | 15.2 | 13.1 | 13.5 |
| Mercury | <0.100 | <0.100 | <0.100 | <0.100 |
| Nickel | 5.10 | 5.00 | 4.80 | 4.97 |
| Selenium | 0.61 | 0.60 | 0.59 | 0.60 |
| Silver | <1.00 | <1.00 | 3.00 | 1.67 |
| Thallium | <0.20 | <0.20 | <0.20 | <0.20 |
| Zinc | 14.9 | 16.6 | 13.7 | 15.1 |
| Iron | 6,460 | 6,910 | 6,540 | 6,637 |
| | | | | *(Sheet 4 of 5)* |

| Table A3 (Concluded) | | | | | | |
|---|---|---|---|---|---|---|
| | Individual Sample Concentration, mg/kg | | | | | |
| Volatiles | CR-8 | CR-10 | CR-11 | CR-12 | CR-13 | CR-14 |
| Chloromethane | <0.022 | <0.016 | <0.028 | <0.014 | <0.014 | <0.015 |
| Bromomethane | <0.022 | <0.016 | <0.028 | <0.014 | <0.014 | <0.015 |
| Vinyl Chloride | <0.022 | <0.016 | <0.028 | <0.014 | <0.014 | <0.015 |
| Chloroethane | <0.022 | <0.016 | <0.028 | <0.014 | <0.014 | <0.015 |
| Methylene Chloride | 0.014B | 0.62B | 0.014B | 0.0077B | 0.013B | 0.017B |
| 1,1-Dichloroethene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| 1,1-Dichloroethane | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Trans-1,2-Dichloroethene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| cis-1,2-Dichloroethene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Chloroform | <0.011 | 0.0014J | <0.014 | <0.0070 | 0.0035J | <0.0075 |
| 1,2-Dichloroethane | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| 1,1,1-Trichloroethane | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Carbon Tetrachloride | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Bromodichloromethane | <0.011 | <0.0080 | <0.014 | <0.0070 | 0.0018J | <0.0075 |
| 1,2-Dichloropropane | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Trans-1,3-Dichloropropene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Trichloroethene | <0.011 | 0.0036J | 0.0015J | <0.0070 | <0.0070 | <0.0075 |
| Dibromochloromethane | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| cis-1,3-Dichloropropene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| 1,1,2-Trichloroethane | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Benzene | <0.011 | <0.0080 | <0.014 | 0.00099J | <0.0070 | <0.0075 |
| Bromoform | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| 1,1,2,2-Tetrachloroethane | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Tetrachloroethene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Toluene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Chlorobenzene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Ethylbenzene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Acetone | 0.18BJ | 0.076BJ | 0.095BJ | 0.13BJ | 0.022BJ | 0.011BJ |
| 2-Butanone | <0.22 | <0.16 | <0.28 | <0.14 | <0.14 | <0.15 |
| Carbondisulfide | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| 2-Hexanone | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| 4-Methyl-2-Pentanone | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Styrene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| Vinyl Acetate | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| T-Xylene | <0.011 | <0.0080 | <0.014 | <0.0070 | <0.0070 | <0.0075 |
| | | | | | | *(Sheet 5 of 5)* |

### Table A4
### Bulk Chemistry Analysis for Reach 2 Site Water

| Analyte | Concentration, mg/L | | |
|---|---|---|---|
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Average** |
| Phenol | <0.015 | <0.010 | <0.013 |
| 2-Chlorophenol | <0.015 | <0.010 | <0.013 |
| 2-Nitrophenol | <0.015 | <0.010 | <0.013 |
| 2,4-Dimethylphenol | <0.015 | <0.010 | <0.013 |
| 2,4-Dichlorophenol | <0.015 | <0.010 | <0.013 |
| 4-Chloro-3-Methylphenol | <0.030 | <0.010 | <0.020 |
| 2,4,6-Trichlorophenol | <0.015 | <0.010 | <0.013 |
| 2,4-Dinitrophenol | <0.075 | <0.050 | <0.063 |
| 4-Nitrophenol | <0.075 | <0.050 | <0.063 |
| 2-Methyl-4,6-Dinotrophenol | <0.075 | <0.050 | <0.063 |
| Pentachlorophenol | <0.075 | <0.050 | <0.063 |
| Benzoic Acid | <0.075 | <0.050 | <0.063 |
| 2-Methylphenol | <0.015 | <0.010 | <0.013 |
| 4-Methylphenol | <0.015 | <0.010 | <0.013 |
| 2,4,5-Trichlorophenol | <0.015 | <0.010 | <0.013 |
| Benzyl Alcohol | <0.030 | <0.020 | <0.025 |
| N-Nitrosodimethylamine | <0.015 | <0.010 | <0.013 |
| Bis(2-Chloroisopropyl)Ether | <0.015 | <0.010 | <0.013 |
| N-Nitroso-Di-N-Propylamine | <0.015 | <0.010 | <0.013 |
| Nitrobenzene | <0.015 | <0.010 | <0.013 |
| Isophorone | <0.015 | <0.010 | <0.013 |
| Bis(2-Chloroethoxy)Methane | <0.015 | <0.010 | <0.013 |
| 2,6-Dinitrotoluene | <0.015 | <0.010 | <0.013 |
| 2,4-Dinitrotoluene | <0.015 | <0.010 | <0.013 |
| 1,2-Diphenylhydrazine | <0.015 | <0.010 | <0.013 |
| Benzidine | <0.075 | <0.050 | <0.063 |
| 3,3'Dichlorobenzidine | <0.030 | <0.020 | <0.025 |
| Bis(2-Chloroethyl)Ether | <0.015 | <0.010 | <0.013 |
| 1,3-Dichlorobenzene | <0.015 | <0.010 | <0.013 |
| 1,4-Dichlorobenzene | <0.015 | <0.010 | <0.013 |
| 1,2-Dichlorobenzene | <0.015 | <0.010 | <0.013 |
| Hexachloroethane | <0.015 | <0.010 | <0.013 |
| 1,2,4-Trichlorobenzene | <0.015 | <0.010 | <0.013 |
| Naphthalene | <0.015 | <0.010 | <0.013 |
| Hexachlorobutadiene | <0.015 | <0.010 | <0.013 |
| Hexachlorocyclopentadiene | <0.015 | <0.010 | <0.013 |

*(Sheet 1 of 4)*

| Table A4 (Continued) | | | |
|---|---|---|---|
| **Analyte** | **Concentration, mg/L** | | |
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Average** |
| 2-Chloronaphthalene | <0.015 | <0.010 | <0.013 |
| Acenaphthylene | <0.015 | <0.010 | <0.013 |
| Dimethyl Phthalate | <0.015 | <0.010 | <0.013 |
| Acenaphthene | <0.015 | <0.010 | <0.013 |
| Fluorene | <0.015 | <0.010 | <0.013 |
| Diethyl Phthalate | <0.015 | <0.010 | <0.013 |
| 4-Chlorophenyl Phenyl Ether | <0.015 | <0.010 | <0.013 |
| N-Nitrosodiphenyl Amine | <0.015 | <0.010 | <0.013 |
| 4-Bromophenyl Ether | <0.015 | <0.010 | <0.013 |
| Hexachlorobenzene | <0.015 | <0.010 | <0.013 |
| Phenanthrene | <0.015 | <0.010 | <0.013 |
| Anthracene | <0.015 | <0.010 | <0.013 |
| Dibutylphthalate | <0.010 | <0.010 | <0.010 |
| Fluoranthene | <0.010 | <0.010 | <0.010 |
| Pyrene | <0.015 | <0.010 | <0.013 |
| Butylbenzylphthalate | <0.015 | <0.010 | <0.013 |
| Chrysene | <0.015 | <0.010 | <0.013 |
| Benzo(a)Anthracene | <0.015 | <0.010 | <0.013 |
| Bis(2-Ethylhexyl)Phthalate | 0.0046J | <0.010 | 0.0073J |
| Di-N-Octylphthalate | <0.015 | <0.010 | <0.013 |
| Benzo(b)Fluoranthene | <0.015 | <0.010 | <0.013 |
| Benzo(k)Fluoranthene | <0.015 | <0.010 | <0.013 |
| Benzo(a)Pyrene | <0.015 | <0.010 | <0.013 |
| Indeno(1,2,3-C,D)Pyrene | <0.015 | <0.010 | <0.013 |
| Dibenzo(A,H)Anthracene | <0.015 | <0.010 | <0.013 |
| Benzo(G,H,I)Perylene | <0.015 | <0.010 | <0.013 |
| Aniline | <0.030 | <0.020 | <0.025 |
| 4-Chloroaniline | <0.030 | <0.020 | <0.025 |
| Dibenzofuran | <0.015 | <0.010 | <0.013 |
| 2-Methylnaphthalene | <0.015 | <0.010 | <0.013 |
| 2-Nitroaniline | <0.075 | <0.050 | <0.063 |
| 3-Nitroaniline | <0.075 | <0.050 | <0.063 |
| 4-Nitroaniline | <0.075 | <0.050 | <0.063 |
| | | | *(Sheet 2 of 4)* |

| Table A4 (Continued) | | | |
|---|---|---|---|
| **Analyte** | **Concentration, mg/L** | | |
| **Pesticides/PCBs** | **Replicate 1** | **Replicate 2** | **Average** |
| Aldrin | <0.000063 | <0.000051 | <0.000057 |
| A-BHC | <0.000048 | <0.000038 | <0.000043 |
| B-BHC | <0.000095 | <0.000076 | <0.000086 |
| G-BHC | <0.000063 | <0.000051 | <0.000057 |
| D-BHC | <0.00014 | <0.00011 | <0.00013 |
| PPDDD | <0.00017 | <0.00014 | <0.00016 |
| PPDDE | <0.000063 | 0.00015 | 0.00011 |
| PPDDT | <0.00019 | 0.014 | 0.0071 |
| Heptachlor | <0.000048 | <0.000038 | <0.000043 |
| Dieldrin | <0.000032 | <0.000025 | <0.000029 |
| A-Endosulfan | <0.00022 | <0.00018 | <0.00020 |
| B-Endosulfan | <0.000063 | <0.00023 | <0.00015 |
| Endosulfan sulfate | <0.0010 | <0.00084 | <0.00092 |
| Endrin | <0.000095 | <0.00042 | <0.00026 |
| Endrin Aldehyde | <0.00037 | <0.00015 | <0.00026 |
| Heptachlor Epoxide | <0.0013 | <0.0011 | <0.0012 |
| Methoxychlor | <0.0029 | <0.0023 | <0.0026 |
| Chlordane | <0.00022 | <0.00018 | <0.00020 |
| Toxaphene | <0.0038 | 0.0027J | 0.0033J |
| PCB-1016 | <0.00095 | <0.00076 | <0.00086 |
| PCB-1221 | <0.00095 | <0.00076 | <0.00086 |
| PCB-1232 | <0.00095 | <0.00076 | <0.00086 |
| PCB-1242 | <0.00095 | <0.00076 | <0.00086 |
| PCB-1248 | <0.00022 | <0.00018 | <0.00020 |
| PCB-1254 | <0.00022 | <0.00018 | <0.00020 |
| PCB-1260 | <0.00022 | <0.00018 | <0.00020 |
| **Other Organics** | | | |
| Total Organic Carbon | 6.8 | 7.2 | 7.0 |
| Total Recoverable Petroleum Hydrocarbons | <0.5 | <0.5 | <0.5 |
| | | | ***(Sheet 3 of 4)*** |

## Table A4 (Concluded)

| Analyte | Concentration, mg/L | | | |
|---|---|---|---|---|
| **Metals** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Antimony | <0.0030 | <0.0030 | <0.0030 | <0.0030 |
| Arsenic | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Beryllium | <0.001 | <0.001 | <0.001 | <0.001 |
| Cadmium | 0.00022 | <0.00020 | <0.00020 | 0.00021 |
| Chromium | <0.005 | <0.005 | <0.005 | <0.005 |
| Copper | <0.001 | <0.001 | <0.001 | <0.001 |
| Lead | 0.0027 | 0.0017 | <0.0010 | 0.0018 |
| Mercury | <0.0002 | <0.0002 | <0.0002 | <0.0002 |
| Nickel | <0.005 | <0.005 | <0.005 | <0.005 |
| Selenium | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Silver | <0.010 | <0.010 | <0.010 | <0.010 |
| Thallium | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Zinc | 0.073 | 0.026 | 0.027 | 0.042 |
| Iron | 0.716 | 0.722 | 0 737 | 0.725 |
| | | | | *(Sheet 4 of 4)* |

**Table A5**
**Bulk Chemistry Analysis of Composite Sediment from Reach 3**

| Analyte | Concentration, mg/kg | | | |
|---|---|---|---|---|
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Phenol | <1.2 | <1.2 | <1.1 | <1.2 |
| 2-Chlorophenol | <1.2 | <1.2 | <1.1 | <1.2 |
| 2-Nitrophenol | <1.2 | <1.2 | <1.1 | <1.2 |
| 2,4-Dimethylphenol | <1.2 | <1.2 | <1.1 | <1.2 |
| 2,4-Dichlorophenol | <1.2 | <1.2 | <1.1 | <1.2 |
| 4-Chloro-3-Methylphenol | <2.4 | <2.4 | <2.2 | <2.3 |
| 2,4,6-Trichlorophenol | <1.2 | <1.2 | <1.1 | <1.2 |
| 2,4-Dinitrophenol | <6.0 | <6.0 | <5.5 | <5.8 |
| 4-Nitrophenol | <6.0 | <6.0 | <5.5 | <5.8 |
| 2-Methyl-4,6-Dinotrophenol | <6.0 | <6.0 | <5.5 | <5.8 |
| Pentachlorophenol | <6.0 | <6.0 | <5.5 | <5.8 |
| Benzoic Acid | <6.0 | <6.0 | <5.5 | <5.8 |
| 2-Methylphenol | <1.2 | <1.2 | <1.1 | <1.2 |
| 4-Methylphenol | <1.2 | <1.2 | <1.1 | <1.2 |
| 2,4,5-Trichlorophenol | <1.2 | <1.2 | <1.1 | <1.2 |
| Benzyl Alcohol | <2.4 | <2.4 | <2.2 | <2.3 |
| N-Nitrosodimethylamine | <1.2 | <1.2 | <1.1 | <1.2 |
| Bis(2-Chloroisopropyl)Ether | <1.2 | <1.2 | <1.1 | <1.2 |
| N-Nitroso-Di-N-Propylamine | <1.2 | <1.2 | <1.1 | <1.2 |
| Nitrobenzene | <1.2 | <1.2 | <1.1 | <1.2 |
| Isophorone | <1.2 | <1.2 | <1.1 | <1.2 |
| Bis(2-Chloroethoxy)Methane | <1.2 | <1.2 | <1.1 | <1.2 |
| 2,6-Dinitrotoluene | <1.2 | <1.2 | <1.1 | <1.2 |
| 2,4-Dinitrotoluene | <1.2 | <1.2 | <1.1 | <1.2 |
| 1,2-Diphenylhydrazine | <1.2 | <1.2 | <1.1 | <1.2 |
| Benzidine | <6.0 | <6.0 | <5.5 | <5.8 |
| 3,3'Dichlorobenzidine | <2.4 | <2.4 | <2.2 | <2.3 |
| Bis(2-Chloroethyl)Ether | <1.2 | <1.2 | <1.1 | <1.2 |
| 1,3-Dichlorobenzene | <1.2 | <1.2 | <1.1 | <1.2 |
| 1,4-Dichlorobenzene | <1.2 | <1.2 | <1.1 | <1.2 |
| 1,2-Dichlorobenzene | <1.2 | <1.2 | <1.1 | <1.2 |
| Hexachloroethane | <1.2 | <1.2 | <1.1 | <1.2 |
| 1,2,4-Trichlorobenzene | <1.2 | <1.2 | <1.1 | <1.2 |
| Naphthalene | <1.2 | <1.2 | <1.1 | <1.2 |
| Hexachlorobutadiene | <1.2 | <1.2 | <1.1 | <1.2 |
| Hexachlorocyclopentadiene | <1.2 | <1.2 | <1.1 | <1.2 |

*(Sheet 1 of 6)*

| Table A5 (Continued) | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/kg** | | | |
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| 2-Chloronaphthalene | <1.2 | <1.2 | <1.1 | <1.2 |
| Acenaphthylene | <1.2 | <1.2 | <1.1 | <1.2 |
| Dimethyl Phthalate | <1.2 | <1.2 | <1.1 | <1.2 |
| Acenaphthene | <1.2 | <1.2 | <1.1 | <1.2 |
| Fluorene | <1.2 | <1.2 | <1.1 | <1.2 |
| Diethyl Phthalate | <1.2 | <1.2 | 0.06J | 0.82J |
| 4-Chlorophenyl Phenyl Ether | <1.2 | <1.2 | <1.1 | <1.2 |
| N-Nitrosodiphenyl Amine | <1.2 | <1.2 | <1.1 | <1.2 |
| 4-Bromophenyl Ether | <1.2 | <1.2 | <1.1 | <1.2 |
| Hexachlorobenzene | <1.2 | <1.2 | <1.1 | <1.2 |
| Phenanthrene | <1.2 | 0.04J | <1.1 | <1.2 |
| Anthracene | <1.2 | <1.2 | <1.1 | <1.2 |
| Dibutylphthalate | 0.28BJ | 1.7B | 0.82BJ | 0.93BJ |
| Fluoranthene | 0.04J | 0.04J | 0.04J | 0.04J |
| Pyrene | 0.08J | 0.05J | 0.06J | 0.06J |
| Butylbenzylphthalate | <1.2 | <1.2 | <1.1 | <1.2 |
| Chrysene | 0.04J | <1.2 | <1.1 | 0.78J |
| Benzo(a)Anthracene | <1.2 | <1.2 | <1.1 | <1.2 |
| Bis(2-Ethylhexyl)Phthalate | 0.27BJ | 0.12BJ | 0.06BJ | 0.15BJ |
| Di-N-Octylphthalate | <1.2 | <1.2 | <1.1 | <1.2 |
| Benzo(b)Fluoranthene | <1.2 | <1.2 | <1.1 | <1.2 |
| Benzo(k)Fluoranthene | <1.2 | <1.2 | <1.1 | <1.2 |
| Benzo(a)Pyrene | <1.2 | <1.2 | <1.1 | <1.2 |
| Indeno(1,2,3-C,D)Pyrene | <1.2 | <1.2 | <1.1 | <1.2 |
| Dibenzo(A,H)Anthracene | <1.2 | <1.2 | <1.1 | <1.2 |
| Benzo(G,H,I)Perylene | <1.2 | <1.2 | <1.1 | <1.2 |
| Aniline | <2.4 | <2.4 | <2.2 | <2.3 |
| 4-Chloroaniline | <2.4 | <2.4 | <2.2 | <2.3 |
| Dibenzofuran | <1.2 | <1.2 | <1.1 | <1.2 |
| 2-Methylnaphthalene | <1.2 | <1.2 | <1.1 | <1.2 |
| 2-Nitroaniline | <6.0 | <6.0 | <5.5 | <5.8 |
| 3-Nitroaniline | <6.0 | <6.0 | <5.5 | <5.8 |
| 4-Nitroaniline | <6.0 | <6.0 | <5.5 | <5.8 |
| Perylene | 0.16J | 0.18J | 0.18J | 0.17J |
| | | | | *(Sheet 2 of 6)* |

| Table A5 (Continued) | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/kg** | | | |
| **Pesticides/PCBs** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Aldrin | <0.0022 | <0.0022 | 0.0020J | 0.0021J |
| A-BHC | <0.0017 | <0.0017 | <0.0017 | <0.0017 |
| B-BHC | <0.0034 | <0.0034 | <0.0034 | <0.0034 |
| G-BHC | <0.0022 | <0.0022 | <0.0022 | <0.0022 |
| D-BHC | 0.022 | 0.028 | 0.023 | 0.024 |
| PPDDD | <0.0062 | <0.0062 | <0.0062 | <0.0062 |
| PPDDE | <0.0022 | <0.0022 | <0.0022 | <0.0022 |
| PPDDT | <0.0068 | <0.0068 | <0.0068 | <0.0068 |
| Heptachlor | <0.0017 | <0.0017 | <0.0017 | <0.0017 |
| Dieldrin | 0.0011 | 0.0011 | 0.0014 | 0.0012 |
| A-Endosulfan | <0.0079 | <0.0079 | <0.0079 | <0.0079 |
| B-Endosulfan | <0.0022 | <0.0022 | <0.0022 | <0.0022 |
| Endosulfan sulfate | <0.038 | <0.038 | <0.038 | <0.038 |
| Endrin | <0.0034 | <0.0034 | <0.0034 | <0.0034 |
| Endrin Aldehyde | <0.016 | <0.016 | <0.016 | <0.016 |
| Heptachlor Epoxide | 0.034J | 0.034J | 0.029J | 0.032J |
| Methoxychlor | <0.099 | <0.099 | <0.099 | <0.099 |
| Chlordane | <0.0079 | <0.0079 | <0.0079 | <0.0079 |
| Toxaphene | <0.14 | <0.14 | <0.14 | <0.14 |
| PCB-1016 | <0.034 | <0.034 | <0.034 | <0.034 |
| PCB-1221 | <0.034 | <0.034 | <0.034 | <0.034 |
| PCB-1232 | <0.034 | <0.034 | <0.034 | <0.034 |
| PCB-1242 | <0.034 | <0.034 | <0.034 | <0.034 |
| PCB-1248 | <0.034 | <0.034 | <0.034 | <0.034 |
| PCB-1254 | <0.034 | <0.034 | <0.034 | <0.034 |
| PCB-1260 | <0.034 | <0.034 | <0.034 | <0.034 |
| **Other Organics** | | | | |
| Total Organic Carbon | 12,099 | 10,529 | 8,403 | 10,344 |
| Total Recoverable Petroleum Hydrocarbons | 110 | <25 | <25 | 53 |
| | | | | ***(Sheet 3 of 6)*** |

| Table A5 (Continued) | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/kg** | | | |
| **Metals** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Antimony | <0.30 | <0.30 | <0.30 | <0.30 |
| Arsenic | 2.88 | 2.46 | 2.42 | 2.59 |
| Beryllium | 1.10 | 0.999 | 1.00 | 1.03 |
| Cadmium | 0.268 | 0.154 | 0.192 | 0.205 |
| Chromium | 8.60 | 7.59 | 8.09 | 8.09 |
| Copper | 9.60 | 8.59 | 9.29 | 9.16 |
| Lead | 13.6 | 13.1 | 13.8 | 13.5 |
| Mercury | <0.100 | <0.100 | <0.100 | <0.100 |
| Nickel | 8.00 | 6.79 | 7.49 | 7.43 |
| Selenium | 0.33 | 0.36 | 0.26 | 0.32 |
| Silver | <1.00 | <1.00 | <1.00 | <1.00 |
| Thallium | <0.20 | <0.20 | <0.20 | <0.20 |
| Zinc | 28.6 | 26.1 | 31.3 | 28.7 |
| Iron | 9,610 | 8,360 | 9,560 | 9,177 |
| | | | | *(Sheet 4 of 6)* |

| Table A5 (Continued) | | | | | | |
|---|---|---|---|---|---|---|
| | Individual Sample Concentration, mg/kg | | | | | |
| Volatiles | CR-15 | CR-16 | CR-17 | CR-18 | CR-19 | CR-20 |
| Chloromethane | <0.018 | <0.46 | <0.018 | <0.018 | <0.026 | <0.026 |
| Bromomethane | <0.018 | <0.46 | <0.018 | <0.018 | <0.026 | <0.026 |
| Vinyl Chloride | <0.018 | <0.46 | <0.018 | <0.018 | <0.026 | <0.026 |
| Chloroethane | <0.018 | <0.46 | <0.018 | <0.018 | <0.026 | <0.026 |
| Methylene Chloride | 0.025B | 0.60B | 0.015B | 0.016B | 0.018B | <0.013 |
| 1,1-Dichloroethene | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| 1,1-Dichloroethane | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Trans-1,2-Dichloroethene | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| cis-1,2-Dichloroethene | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Chloroform | <0.009 | <0.23 | <0.0090 | 0.0013J | 0.0022J | 0.0033J |
| 1,2-Dichloroethane | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| 1,1,1-Trichloroethane | <0.009 | <0.23 | 0.0032J | <0.0090 | <0.013 | <0.013 |
| Carbon Tetrachloride | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Bromodichloromethane | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| 1,2-Dichloropropane | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Trans-1,3-Dichloropropene | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Trichloroethene | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Dibromochloromethane | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| cis-1,3-Dichloropropene | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| 1,1,2-Trichloroethane | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Benzene | <0.009 | 0.022J | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Bromoform | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| 1,1,2,2-Tetrachloroethane | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Tetrachloroethene | <0.009 | <0.23 | 0.0071J | 0.0020J | <0.013 | <0.013 |
| Toluene | <0.009 | 0.024J | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Chlorobenzene | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Ethylbenzene | <0.009 | 0.032J | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Acetone | 0.25B | <4.6 | 0.40B | 0.21B | 0.74B | 0.23B |
| 2-Butanone | <0.18 | <4.6 | <0.18 | 0.018J | <0.26 | <0.26 |
| Carbondisulfide | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| 2-Hexanone | <0.09 | <2.3 | <0.090 | <0.090 | 0.023 | <0.13 |
| 4-Methyl-2-Pentanone | <0.09 | <2.3 | <0.090 | <0.090 | <0.13 | <0.13 |
| Styrene | <0.009 | <0.23 | <0.0090 | <0.0090 | <0.013 | <0.013 |
| Vinyl Acetate | <0.09 | <2.3 | <0.090 | <0.090 | <0.13 | <0.13 |
| T-Xylene | <0.009 | 0.22J | <0.0090 | <0.0090 | <0.013 | <0.013 |
| | | | | | | *(Sheet 5 of 6)* |

| Table A5 (Concluded) | | | | | | |
|---|---|---|---|---|---|---|
| | Individual Sample Concentration, mg/kg | | | | | |
| Volatiles | CR-21 | CR-24 | CR-25 | CR-26 | CR-27 | CR-28 |
| Chloromethane | <0.032 | <0.016 | <0.015 | <0.018 | <0.017 | <0.017 |
| Bromomethane | <0.032 | <0.016 | <0.015 | <0.018 | <0.017 | <0.017 |
| Vinyl Chloride | <0.032 | <0.016 | <0.015 | <0.018 | <0.017 | <0.017 |
| Chloroethane | <0.032 | <0.016 | <0.015 | <0.018 | <0.017 | <0.017 |
| Methylene Chloride | 0.031B | 0.033B | 0.023B | 0.020B | 0.011B | 0.012B |
| 1,1-Dichloroethene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| 1,1-Dichloroethane | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Trans-1,2-Dichloroethene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| cis-1,2-Dichloroethene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Chloroform | 0.0024J | 0.0043J | 0.0051J | <0.0090 | <0.0085 | <0.0085 |
| 1,2-Dichloroethane | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| 1,1,1-Trichloroethane | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Carbon Tetrachloride | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Bromodichloromethane | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| 1,2-Dichloropropane | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Trans-1,3-Dichloropropene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Trichloroethene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Dibromochloromethane | <0.016 | <0.0080 | 0.0016J | <0.0090 | <0.0085 | <0.0085 |
| cis-1,3-Dichloropropene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| 1,1,2-Trichloroethane | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Benzene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Bromoform | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| 1,1,2,2-Tetrachloroethane | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Tetrachloroethene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Toluene | <0.016 | <0.0080 | <0.0075 | 0.0033J | 0.0015J | <0.0085 |
| Chlorobenzene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Ethylbenzene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Acetone | 0.66B | 0.61B | 0.18B | 0.16B | 0.092BJ | 0.12BJ |
| 2-Butanone | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.17 | <0.17 |
| Carbondisulfide | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| 2-Hexanone | <0.16 | <0.080 | <0.075 | <0.090 | <0.085 | <0.085 |
| 4-Methyl-2-Pentanone | <0.16 | <0.080 | <0.075 | <0.090 | <0.085 | <0.085 |
| Styrene | <0.016 | <0.0080 | <0.0075 | <0.0090 | <0.0085 | <0.0085 |
| Vinyl Acetate | <0.16 | <0.080 | <0.075 | <0.090 | <0.085 | <0.085 |
| T-Xylene | <0.16 | <0.080 | <0.075 | <0.090 | <0.085 | <0.085 |
| | | | | | | *(Sheet 6 of 6)* |

**Table A6**
**Bulk Chemistry Analysis for Reach 3 Site Water**

| Analyte | Concentration, mg/L | | |
|---|---|---|---|
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Average** |
| Phenol | <0.010 | <0.014 | <0.012 |
| 2-Chlorophenol | <0.010 | <0.014 | <0.012 |
| 2-Nitrophenol | <0.010 | <0.014 | <0.012 |
| 2,4-Dimethylphenol | <0.010 | <0.014 | <0.012 |
| 2,4-Dichlorophenol | <0.010 | <0.014 | <0.012 |
| 4-Chloro-3-Methylphenol | <0.010 | <0.028 | <0.019 |
| 2,4,6-Trichlorophenol | <0.010 | <0.014 | <0.012 |
| 2,4-Dinitrophenol | <0.050 | <0.070 | <0.060 |
| 4-Nitrophenol | <0.050 | <0.070 | <0.060 |
| 2-Methyl-4,6-Dinotrophenol | <0.050 | <0.070 | <0.060 |
| Pentachlorophenol | <0.050 | <0.070 | <0.060 |
| Benzoic Acid | <0.050 | <0.070 | <0.060 |
| 2-Methylphenol | <0.010 | <0.014 | <0.012 |
| 4-Methylphenol | <0.010 | <0.014 | <0.012 |
| 2,4,5-Trichlorophenol | <0.010 | <0.014 | <0.012 |
| Benzyl Alcohol | <0.020 | <0.028 | <0.024 |
| N-Nitrosodimethylamine | <0.010 | <0.014 | <0.012 |
| Bis(2-Chloroisopropyl)Ether | <0.010 | <0.014 | <0.012 |
| N-Nitroso-Di-N-Propylamine | <0.010 | <0.014 | <0.012 |
| Nitrobenzene | <0.010 | <0.014 | <0.012 |
| Isophorone | <0.010 | <0.014 | <0.012 |
| Bis(2-Chloroethoxy)Methane | <0.010 | <0.014 | <0.012 |
| 2,6-Dinitrotoluene | <0.010 | <0.014 | <0.012 |
| 2,4-Dinitrotoluene | <0.010 | <0.014 | <0.012 |
| 1,2-Diphenylhydrazine | <0.010 | <0.014 | <0.012 |
| Benzidine | <0.050 | <0.070 | <0.060 |
| 3,3'Dichlorobenzidine | <0.020 | <0.028 | <0.024 |
| Bis(2-Chloroethyl)Ether | <0.010 | <0.014 | <0.012 |
| 1,3-Dichlorobenzene | <0.010 | <0.014 | <0.012 |
| 1,4-Dichlorobenzene | <0.010 | <0.014 | <0.012 |
| 1,2-Dichlorobenzene | <0.010 | <0.014 | <0.012 |
| Hexachloroethane | <0.010 | <0.014 | <0.012 |
| 1,2,4-Trichlorobenzene | <0.010 | <0.014 | <0.012 |
| Naphthalene | <0.010 | <0.014 | <0.012 |
| Hexachlorobutadiene | <0.010 | <0.014 | <0.012 |
| Hexachlorocyclopentadiene | <0.010 | <0.014 | <0.012 |

*(Sheet 1 of 4)*

## Table A6 (Continued)

| Analyte | Concentration, mg/L | | |
|---|---|---|---|
| **Semivolatiles** | **Replicate 1** | **Replicate 2** | **Average** |
| 2-Chloronaphthalene | <0.010 | <0.014 | <0.012 |
| Acenaphthylene | <0.010 | <0.014 | <0.012 |
| Dimethyl Phthalate | <0.010 | <0.014 | <0.012 |
| Acenaphthene | <0.010 | <0.014 | <0.012 |
| Fluorene | <0.010 | <0.014 | <0.012 |
| Diethyl Phthalate | <0.010 | <0.014 | <0.012 |
| 4-Chlorophenyl Phenyl Ether | <0.010 | <0.014 | <0.012 |
| N-Nitrosodiphenyl Amine | <0.010 | <0.014 | <0.012 |
| 4-Bromophenyl Ether | <0.010 | <0.014 | <0.012 |
| Hexachlorobenzene | <0.010 | <0.014 | <0.012 |
| Phenanthrene | <0.010 | <0.014 | <0.012 |
| Anthracene | <0.010 | <0.014 | <0.012 |
| Dibutylphthalate | <0.010 | <0.014 | <0.012 |
| Fluoranthene | <0.010 | <0.014 | <0.012 |
| Pyrene | <0.010 | <0.014 | <0.012 |
| Butylbenzylphthalate | <0.010 | <0.014 | <0.012 |
| Chrysene | <0.010 | <0.014 | <0.012 |
| Benzo(a)Anthracene | <0.010 | <0.014 | <0.012 |
| Bis(2-Ethylhexyl)Phthalate | <0.010 | <0.014 | <0.012 |
| Di-N-Octylphthalate | <0.010 | <0.014 | <0.012 |
| Benzo(b)Fluoranthene | <0.010 | <0.014 | <0.012 |
| Benzo(k)Fluoranthene | <0.010 | <0.014 | <0.012 |
| Benzo(a)Pyrene | <0.010 | <0.014 | <0.012 |
| Indeno(1,2,3-C,D)Pyrene | <0.010 | <0.014 | <0.012 |
| Dibenzo(A,H)Anthracene | <0.010 | <0.014 | <0.012 |
| Benzo(G,H,I)Perylene | <0.010 | <0.014 | <0.012 |
| Aniline | <0.020 | <0.028 | <0.024 |
| 4-Chloroaniline | <0.020 | <0.028 | <0.024 |
| Dibenzofuran | <0.010 | <0.014 | <0.012 |
| 2-Methylnaphthalene | <0.010 | <0.014 | <0.012 |
| 2-Nitroaniline | <0.050 | <0.070 | <0.060 |
| 3-Nitroaniline | <0.050 | <0.070 | <0.060 |
| 4-Nitroaniline | <0.050 | <0.070 | <0.060 |

*(Sheet 2 of 4)*

| Table A6 (Continued) | | | |
|---|---|---|---|
| **Analyte** | **Concentration, mg/L** | | |
| **Pesticides/PCBs** | **Replicate 1** | **Replicate 2** | **Average** |
| Aldrin | <0.000039 | <0.000053 | <0.000046 |
| A-BHC | <0.000029 | <0.000040 | <0.000035 |
| B-BHC | <0.000058 | <0.000080 | <0.000069 |
| G-BHC | <0.000039 | <0.000053 | <0.000046 |
| D-BHC | <0.000087 | <0.00012 | <0.00010 |
| PPDDD | <0.00011 | <0.00015 | <0.00013 |
| PPDDE | <0.000039 | <0.000053 | <0.000046 |
| PPDDT | <0.00012 | 0.0067 | 0.0034 |
| Heptachlor | <0.000029 | <0.000040 | <0.000035 |
| Dieldrin | <0.000019 | <0.000027 | <0.000023 |
| A-Endosulfan | <0.00014 | <0.00019 | <0.00017 |
| B-Endosulfan | <0.000039 | <0.00011 | <0.00025 |
| Endosulfan sulfate | <0.00064 | <0.00088 | <0.00076 |
| Endrin | <0.000058 | <0.00018 | <0.00012 |
| Endrin Aldehyde | <0.00022 | <0.00031 | <0.00027 |
| Heptachlor Epoxide | <0.00081 | <0.0011 | <0.00096 |
| Methoxychlor | <0.0017 | <0.0024 | <0.0021 |
| Chlordane | <0.00014 | <0.00018 | <0.00016 |
| Toxaphene | <0.0023 | 0.0016J | 0.0020J |
| PCB-1016 | <0.00058 | <0.00080 | <0.00069 |
| PCB-1221 | <0.00058 | <0.00080 | <0.00069 |
| PCB-1232 | <0.00058 | <0.00080 | <0.00069 |
| PCB-1242 | <0.00058 | <0.00080 | <0.00069 |
| PCB-1248 | <0.00014 | <0.00019 | <0.00017 |
| PCB-1254 | <0.00014 | <0.00019 | <0.00017 |
| PCB-1260 | <0.00014 | <0.00019 | <0.00017 |
| **Other Organics** | | | |
| Total Organic Carbon | 7.2 | 5.9 | 6.6 |
| Total Recoverable Petroleum Hydrocarbons | <0.5 | <0.5 | <0.5 |
| | | | *(Sheet 3 of 4)* |

| Table A6 (Concluded) | | | | |
|---|---|---|---|---|
| **Analyte** | **Concentration, mg/L** | | | |
| **Metals** | **Replicate 1** | **Replicate 2** | **Replicate 3** | **Average** |
| Antimony | <0.0030 | <0.0030 | <0.0030 | <0.0030 |
| Arsenic | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Beryllium | <0.001 | <0.001 | <0.001 | <0.001 |
| Cadmium | 0.00022 | <0.00020 | <0.00020 | 0.00021 |
| Chromium | <0.005 | <0.005 | <0.005 | <0.005 |
| Copper | <0.001 | <0.001 | <0.001 | <0.001 |
| Lead | 0.0020 | <0.0010 | 0.0020 | 0.0017 |
| Mercury | <0.0002 | <0.0002 | <0.0002 | <0.0002 |
| Nickel | <0.005 | <0.005 | <0.005 | <0.005 |
| Selenium | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Silver | <0.010 | <0.010 | <0.010 | <0.010 |
| Thallium | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Zinc | 0.021 | 0.018 | 0.025 | 0.021 |
| Iron | 0.750 | 0.729 | 1.02 | 0.833 |
| | | | | *(Sheet 4 of 4)* |

**Table A7**
**Modified Elutriate Test Chemical Data**

| Semivolatiles | REACH 1 Total Conc. mg/L | REACH 1 Dissolved Conc. mg/L | REACH 2 Total Conc. mg/L | REACH 2 Dissolved Conc. mg/L | REACH 3 Total Conc. mg/L | REACH 3 Dissolved Conc. mg/L |
|---|---|---|---|---|---|---|
| Phenol | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 2-Chlorophenol | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 2-Nitrophenol | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 2,4-Dimethylphenol | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 2,4-Dichlorophenol | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 4-Chloro-3-Methylphenol | <0.020 | <0.020 | <0.040 | <0.020 | <0.020 | <0.020 |
| 2,4,6-Trichlorophenol | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 2,4-Dinitrophenol | <0.050 | <0.050 | <0.10 | <0.050 | <0.050 | <0.050 |
| 4-Nitrophenol | <0.050 | <0.050 | <0.10 | <0.050 | <0.050 | <0.050 |
| 2-Methyl-4,6-Dinotrophenol | <0.050 | <0.050 | <0.10 | <0.050 | <0.050 | <0.050 |
| Pentachlorophenol | <0.050 | <0.050 | <0.10 | <0.050 | <0.050 | <0.050 |
| Benzoic Acid | <0.050 | <0.050 | <0.10 | <0.050 | <0.050 | <0.050 |
| 2-Methylphenol | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 4-Methylphenol | <0.010 | <0.010 | 0.0012J | <0.010 | <0.010 | <0.010 |
| 2,4,5-Trichlorophenol | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Benzyl Alcohol | <0.020 | <0.020 | <0.040 | <0.020 | <0.020 | <0.020 |
| N-Nitrosodimethylamine | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Bis(2-Chloroisopropyl)Ether | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| N-Nitroso-Di-N-Propylamine | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Nitrobenzene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Isophorone | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Bis(2-Chloroethoxy)Methane | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 2,6-Dinitrotoluene | <0.010 | 0.0007J | <0.020 | <0.010 | <0.010 | <0.010 |
| 2,4-Dinitrotoluene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 1,2-Diphenylhydrazine | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Benzidine | <0.050 | <0.050 | <0.10 | <0.050 | <0.050 | <0.050 |
| 3,3'Dichlorobenzidine | <0.020 | <0.020 | <0.040 | <0.020 | <0.020 | <0.020 |
| Bis(2-Chloroethyl)Ether | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 1,3-Dichlorobenzene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 1,4-Dichlorobenzene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 1,2-Dichlorobenzene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Hexachloroethane | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 1,2,4-Trichlorobenzene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Naphthalene | <0.010 | <0.010 | 0.0010J | <0.010 | <0.010 | <0.010 |
| Hexachlorobutadiene | <0.010 | <0.010 | 0.0009J | <0.010 | <0.010 | <0.010 |
| Hexachlorocyclopentadiene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |

*(Sheet 1 of 4)*

**Table A7 (Continued)**

| Semivolatiles | REACH 1 | | REACH 2 | | REACH 3 | |
|---|---|---|---|---|---|---|
| | Total Conc. mg/L | Dissolved Conc. mg/L | Total Conc. mg/L | Dissolved Conc. mg/L | Total Conc. mg/L | Dissolved Conc. mg/L |
| 2-Chloronaphthalene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Acenaphthylene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Dimethyl Phthalate | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Acenaphthene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Fluorene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Diethyl Phthalate | <0.010 | <0.010 | 0.0024J | <0.010 | <0.010 | <0.010 |
| 4-Chlorophenyl Phenyl Ether | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| N-Nitrosodiphenyl Amine | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 4-Bromophenyl Ether | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Hexachlorobenzene | <0.010 | <0.010 | 0.0027J | <0.010 | <0.010 | <0.010 |
| Phenanthrene | <0.010 | <0.010 | 0.0020J | <0.010 | <0.010 | <0.010 |
| Anthracene | <0.010 | <0.010 | 0.0103J | <0.010 | <0.010 | <0.010 |
| Dibutylphthalate | <0.010 | 0.0035BJ | 0.0008BJ | 0.0024BJ | <0.010 | 0.0020BJ |
| Fluoranthene | <0.010 | <0.010 | 0.0018J | <0.010 | <0.010 | <0.010 |
| Pyrene | <0.010 | <0.010 | 0.0029J | <0.010 | <0.010 | <0.010 |
| Butylbenzylphthalate | <0.010 | <0.010 | 0.010J | <0.010 | <0.010 | <0.010 |
| Chrysene | <0.010 | <0.010 | 0.0023J | <0.010 | <0.010 | <0.010 |
| Benzo(a)Anthracene | <0.010 | <0.010 | 0.0015J | <0.010 | <0.010 | <0.010 |
| Bis(2-Ethylhexyl)Phthalate | 0.0008BJ | 0.0023 | 0.0058BJ | 0.0012BJ | 0.010BJ | 0.0042BJ |
| Di-N-Octylphthalate | <0.010 | <0.010 | 0.0021J | <0.010 | 0.0056J | <0.010 |
| Benzo(b)Fluoranthene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Benzo(k)Fluoranthene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Benzo(a)Pyrene | <0.010 | <0.010 | 0.0013J | <0.010 | <0.010 | <0.010 |
| Indeno(1,2,3-C,D)Pyrene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Dibenzo(A,H)Anthracene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Benzo(G,H,I)Perylene | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| Aniline | <0.020 | <0.020 | <0.040 | <0.020 | <0.020 | <0.020 |
| 4-Chloroaniline | <0.020 | <0.020 | <0.040 | <0.020 | <0.020 | <0.020 |
| Dibenzofuran | <0.010 | <0.010 | <0.020 | <0.010 | <0.010 | <0.010 |
| 2-Methylnaphthalene | <0.010 | <0.010 | 0.0012J | <0.010 | <0.010 | <0.010 |
| 2-Nitroaniline | <0.050 | <0.050 | <0.10 | <0.050 | <0.050 | <0.050 |
| 3-Nitroaniline | <0.050 | <0.050 | <0.10 | <0.050 | <0.050 | <0.050 |
| 4-Nitroaniline | <0.050 | <0.050 | <0.10 | <0.050 | <0.050 | <0.050 |

*(Sheet 2 of 4)*

**Table A7 (Continued)**

| Metals | REACH 1 Total Conc. mg/L | REACH 1 Dissolved Conc. mg/L | REACH 2 Total Conc. mg/L | REACH 2 Dissolved Conc. mg/L | REACH 3 Total Conc. mg/L | REACH 3 Dissolved Conc. mg/L |
|---|---|---|---|---|---|---|
| Antimony | <0.0030 | <0.0030 | 0.0106 | <0.0030 | 0.0044 | 0.0030 |
| Arsenic | <0.0020 | <0.0020 | 0.0648 | <0.0020 | 0.0029 | 0.0023 |
| Beryllium | 0.001 | <0.001 | 0.039 | 0.001 | 0.001 | <0.001 |
| Cadmium | 0.00021 | <0.00020 | 0.00263 | <0.00020 | 0.00043 | <0.00020 |
| Chromium | 0.012 | <0.0010 | 1.30 | <0.0010 | 0.0011 | <0.0010 |
| Copper | <0.001 | <0.001 | 0.659 | <0.001 | <0.001 | <0.001 |
| Lead | 0.0063 | <0.0010 | 0.667 | <0.0010 | 0.0045 | <0.0010 |
| Mercury | 0.0009 | <0.0002 | 0.0042 | <0.0002 | 0.0003 | <0.0002 |
| Nickel | 0.008 | <0.001 | 0.737 | <0.001 | 0.008 | <0.001 |
| Selenium | <0.0020 | <0.0020 | 0.0184 | <0.0020 | <0.0020 | <0.0020 |
| Silver | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| Thallium | <0.0020 | <0.0020 | 0.0030 | <0.0020 | <0.0020 | <0.0020 |
| Zinc | 0.062 | <0.010 | 2.16 | <0.010 | 0.163 | <0.010 |
| Iron | 7.29 | <0.025 | 699 | <0.025 | 0.392 | <0.025 |

*(Sheet 3 of 4)*

| Table A7 (Concluded) | | | | | | |
|---|---|---|---|---|---|---|
| | REACH 1 | | REACH 2 | | REACH 3 | |
| Pesticides/PCBs | Total Conc. mg/L | Dissolved Conc. mg/L | Total Conc. mg/L | Dissolved Conc. mg/L | Total Conc. mg/L | Dissolved Conc. mg/L |
| Aldrin | <0.000067 | <0.000067 | <0.000067 | <0.000067 | <0.000067 | <0.000067 |
| A-BHC | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| B-BHC | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| G-BHC | <0.000067 | <0.000067 | <0.000067 | <0.000067 | <0.000067 | <0.000067 |
| D-BHC | <0.00015 | <0.00015 | <0.00015 | <0.00015 | <0.00015 | <0.00015 |
| PPDDD | <0.00018 | <0.00018 | <0.00018 | <0.00018 | <0.00018 | <0.00018 |
| PPDDE | <0.000067 | <0.000067 | <0.000067 | 0.000050J | <0.000067 | <0.000067 |
| PPDDT | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | 0.00014J |
| Heptachlor | <0.000050 | <0.000050 | <0.000050 | 0.000022J | <0.000050 | 0.000023J |
| Dieldrin | <0.000033 | <0.000033 | <0.000033 | <0.000033 | <0.000033 | <0.000033 |
| A-Endosulfan | <0.00023 | <0.00023 | <0.00023 | <0.00023 | <0.00023 | <0.00023 |
| B-Endosulfan | <0.000067 | <0.000067 | <0.000067 | <0.000067 | <0.000067 | <0.000067 |
| Endosulfan sulfate | <0.0011 | <0.0011 | <0.0011 | <0.0011 | <0.0011 | <0.0011 |
| Endrin | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Endrin Aldehyde | <0.00038 | <0.00038 | <0.00038 | <0.00038 | <0.00038 | <0.00038 |
| Heptachlor Epoxide | <0.0014 | <0.0014 | <0.0014 | <0.0014 | <0.0014 | <0.0014 |
| Methoxychlor | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 |
| Chlordane | <0.00023 | <0.00023 | <0.00023 | <0.00023 | <0.00023 | <0.00023 |
| Toxaphene | <0.0040 | <0.0040 | <0.0040 | <0.0040 | <0.0040 | <0.0040 |
| PCB-1016 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| PCB-1221 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| PCB-1232 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| PCB-1242 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| PCB-1248 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| PCB-1254 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| PCB-1260 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| | | | | | | |
| Total Recoverable Petroleum Hydrocarbons | <0.63 | <0.63 | 2.3 | <0.63 | <0.63 | <0.63 |
| | | | | | | |
| Total Suspended Solids | 564 | — | 70,227 | — | 32 | — |
| | | | | | | *(Sheet 4 of 4)* |

**Table A8**
**Composite Sediment Compression Test Data for Reach 1**

| Date | Time | Time Interval hr | Time Interval days | Interface Depth ft |
|---|---|---|---|---|
| 8 Jul | 0815 | 0.00 | | 6.25 |
| | 0830 | 0.25 | | 6.17 |
| | 0845 | 0.50 | | 6.11 |
| | 0900 | 0.75 | | 6.05 |
| | 0915 | 1.00 | | 5.99 |
| | 0930 | 1.25 | | 5.92 |
| | 0945 | 1.50 | | 5.86 |
| | 1000 | 1.75 | | 5.79 |
| | 1015 | 2.00 | | 5.74 |
| | 1030 | 2.25 | | 5.68 |
| | 1045 | 2.50 | | 5.61 |
| | 1100 | 2.75 | | 5.56 |
| | 1115 | 3.00 | | 5.49 |
| | 1130 | 3.25 | | 5.43 |
| | 1145 | 3.50 | | 5.37 |
| | 1200 | 3.75 | | 5.31 |
| | 1215 | 4.00 | | 5.25 |
| | 1245 | 4.50 | | 5.13 |
| | 1315 | 5.00 | | 4.99 |
| | 1345 | 5.50 | | 4.87 |
| | 1415 | 6.00 | | 4.75 |
| | 1445 | 6.50 | | 4.61 |
| | 1515 | 7.00 | | 4.47 |
| | 1545 | 7.50 | | 4.33 |
| | 1615 | 8.00 | | 4.18 |
| | 1715 | 9.00 | | 3.92 |
| | 1815 | 10.00 | | 3.65 |
| | 1915 | 11.00 | | 3.30 |
| | 2015 | 12.00 | | 3.00 |
| 9 Jul | 0830 | 24.25 | 1 | 2.50 |
| 10 Jul | 0830 | 48.25 | 2 | 2.30 |
| 12 Jul | 0815 | 96.00 | 4 | 2.00 |
| 15 Jul | 0815 | 168.00 | 7 | 1.81 |
| 19 Jul | 0815 | 264.00 | 11 | 1.66 |
| 23 Jul | 0815 | 360.00 | 15 | 1.56 |

Notes:
The initial interface depth was 6.25 ft.
The slurry concentration was 83.95 g/L.

**Table A9**
**Composite Sediment Compression Test Data for Reach 2**

| Date | Time | Time Interval hr | Time Interval days | Interface Depth ft |
|---|---|---|---|---|
| 8 Jul | 0835 | 0.00 | | 6.23 |
| | 0845 | 0.17 | | 6.19 |
| | 0900 | 0.42 | | 6.13 |
| | 0915 | 0.67 | | 6.09 |
| | 0930 | 0.92 | | 6.02 |
| | 0945 | 1.17 | | 5.97 |
| | 1000 | 1.42 | | 5.92 |
| | 1015 | 1.67 | | 5.88 |
| | 1030 | 1.92 | | 5.82 |
| | 1045 | 2.17 | | 5.76 |
| | 1100 | 2.42 | | 5.72 |
| | 1115 | 2.67 | | 5.67 |
| | 1130 | 2.92 | | 5.60 |
| | 1145 | 3.17 | | 5.55 |
| | 1200 | 3.42 | | 5.51 |
| | 1215 | 3.67 | | 5.46 |
| | 1230 | 3.92 | | 5.40 |
| | 1245 | 4.17 | | 5.34 |
| | 1315 | 4.67 | | 5.23 |
| | 1345 | 5.17 | | 5.13 |
| | 1415 | 5.67 | | 5.02 |
| | 1445 | 6.17 | | 4.90 |
| | 1515 | 6.67 | | 4.77 |
| | 1545 | 7.17 | | 4.65 |
| | 1615 | 7.67 | | 4.52 |
| | 1715 | 8.67 | | 4.31 |
| | 1815 | 9.67 | | 4.10 |
| | 1915 | 10.67 | | 3.79 |
| | 2015 | 11.67 | | 3.56 |
| 10 Jul | 0835 | 48.00 | 2 | 2.54 |
| 12 Jul | 0835 | 96.00 | 4 | 2.30 |
| 15 Jul | 0835 | 168.00 | 7 | 2.08 |
| 19 Jul | 0835 | 264.00 | 11 | 1.94 |
| 23 Jul | 0835 | 360.00 | 15 | 1.84 |

Notes:
The initial interface depth was 6.23 ft.
The slurry concentration was 90.19 g/L.

**Table A10**
**Composite Sediment Compression Test Data for Reach 3**

| Date | Time | Time Interval hr | Time Interval days | Interface Depth ft |
|---|---|---|---|---|
| 8 Jul | 0905 | 0.00 | | 6.29 |
| | 0920 | 0.25 | | 6.25 |
| | 0935 | 0.50 | | 6.22 |
| | 0950 | 0.75 | | 6.17 |
| | 1005 | 1.00 | | 6.14 |
| | 1020 | 1.25 | | 6.11 |
| | 1035 | 1.50 | | 6.07 |
| | 1050 | 1.75 | | 6.04 |
| | 1105 | 2.00 | | 5.98 |
| | 1120 | 2.25 | | 5.96 |
| | 1135 | 2.50 | | 5.92 |
| | 1150 | 2.75 | | 5.88 |
| | 1205 | 3.00 | | 5.85 |
| | 1220 | 3.25 | | 5.81 |
| | 1235 | 3.50 | | 5.77 |
| | 1250 | 3.75 | | 5.74 |
| | 1320 | 4.25 | | 5.67 |
| | 1350 | 4.75 | | 5.59 |
| | 1420 | 5.25 | | 5.51 |
| | 1450 | 5.75 | | 5.45 |
| | 1520 | 6.25 | | 5.37 |
| | 1550 | 6.75 | | 5.29 |
| | 1620 | 7.25 | | 5.20 |
| | 1720 | 8.25 | | 5.05 |
| | 1820 | 9.25 | | 4.91 |
| | 1915 | 10.17 | | 4.70 |
| | 2015 | 11.17 | | 4.53 |
| 10 Jul | 0905 | 48.00 | 2 | 2.80 |
| 12 Jul | 0905 | 96.00 | 4 | 2.51 |
| 15 Jul | 0905 | 168.00 | 7 | 2.20 |
| 19 Jul | 0905 | 264.00 | 11 | 2.12 |
| 23 Jul | 0905 | 360.00 | 15 | 2.01 |

Notes:
*The initial interface depth was 6.29 ft.*
The slurry concentration was 105.19 g/L.

**Table A11**
**Composite Sediment Zone Test Data for Reach 1**

| Time | Time Interval hr | Interface Depth ft |
|---|---|---|
| 0815 | 0.00 | 6.25 |
| 0830 | 0.25 | 6.17 |
| 0845 | 0.50 | 6.11 |
| 0900 | 0.75 | 6.05 |
| 0915 | 1.00 | 5.99 |
| 0930 | 1.25 | 5.92 |
| 0945 | 1.50 | 5.86 |
| 1000 | 1.75 | 5.79 |
| 1015 | 2.00 | 5.74 |
| 1030 | 2.25 | 5.68 |
| 1045 | 2.50 | 5.61 |
| 1100 | 2.75 | 5.56 |
| 1115 | 3.00 | 5.49 |
| 1130 | 3.25 | 5.43 |
| 1145 | 3.50 | 5.37 |
| 1200 | 3.75 | 5.31 |
| 1215 | 4.00 | 5.25 |
| 1245 | 4.50 | 5.13 |
| 1315 | 5.00 | 4.99 |
| 1345 | 5.50 | 4.87 |
| 1415 | 6.00 | 4.75 |
| 1445 | 6.50 | 4.61 |
| 1515 | 7.00 | 4.47 |
| 1545 | 7.50 | 4.33 |
| 1615 | 8.00 | 4.18 |
| 1715 | 9.00 | 3.92 |
| 1815 | 10.00 | 3.65 |
| 1915 | 11.00 | 3.30 |
| 2015 | 12.00 | 3.00 |

Notes:
The initial interface depth was 6.25 ft.
The slurry concentration was 83.95 g/L.

**Table A12**
**Composite Sediment Zone Test Data for Reach 2**

| Time | Time Interval hr | Interface Depth ft |
|---|---|---|
| 0835 | 0.00 | 6.23 |
| 0845 | 0.17 | 6.19 |
| 0900 | 0.42 | 6.13 |
| 0915 | 0.67 | 6.09 |
| 0930 | 0.92 | 6.02 |
| 0945 | 1.17 | 5.97 |
| 1000 | 1.42 | 5.92 |
| 1015 | 1.67 | 5.88 |
| 1030 | 1.92 | 5.82 |
| 1045 | 2.17 | 5.76 |
| 1100 | 2.42 | 5.72 |
| 1115 | 2.67 | 5.67 |
| 1130 | 2.92 | 5.60 |
| 1145 | 3.17 | 5.55 |
| 1200 | 3.42 | 5.51 |
| 1215 | 3.67 | 5.46 |
| 1230 | 3.92 | 5.40 |
| 1245 | 4.17 | 5.34 |
| 1315 | 4.67 | 5.23 |
| 1345 | 5.17 | 5.13 |
| 1415 | 5.67 | 5.02 |
| 1445 | 6.17 | 4.90 |
| 1515 | 6.67 | 4.77 |
| 1545 | 7.17 | 4.65 |
| 1615 | 7.67 | 4.52 |
| 1715 | 8.67 | 4.31 |
| 1815 | 9.67 | 4.10 |
| 1915 | 10.67 | 3.79 |
| 2015 | 11.67 | 3.56 |

Notes:
The initial interface depth was 6.23 ft.
The slurry concentration was 90.19 g/L.

**Table A13**
**Composite Sediment Zone Test Data for Reach 3**

| Time | Time Interval<br>hr | Interface Depth<br>ft |
|---|---|---|
| 0905 | 0.00 | 6.29 |
| 0920 | 0.25 | 6.25 |
| 0935 | 0.50 | 6.22 |
| 0950 | 0.75 | 6.17 |
| 1005 | 1.00 | 6.14 |
| 1020 | 1.25 | 6.11 |
| 1035 | 1.50 | 6.07 |
| 1050 | 1.75 | 6.04 |
| 1105 | 2.00 | 5.98 |
| 1120 | 2.25 | 5.96 |
| 1135 | 2.50 | 5.92 |
| 1150 | 2.75 | 5.88 |
| 1205 | 3.00 | 5.85 |
| 1220 | 3.25 | 5.81 |
| 1235 | 3.50 | 5.77 |
| 1250 | 3.75 | 5.74 |
| 1320 | 4.25 | 5.67 |
| 1350 | 4.75 | 5.59 |
| 1420 | 5.25 | 5.51 |
| 1450 | 5.75 | 5.45 |
| 1520 | 6.25 | 5.37 |
| 1550 | 6.75 | 5.29 |
| 1620 | 7.25 | 5.20 |
| 1720 | 8.25 | 5.05 |
| 1820 | 9.25 | 4.91 |
| 1915 | 10.17 | 4.70 |
| 2015 | 11.17 | 4.53 |

Notes:
The initial interface depth was 6.29 ft.
The slurry concentration was 105.19 g/L.

| Table A14<br>Composite Sediment Flocculent Settling Test Data for Reach 1[1] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Time hr | Depth from Top of Settling Column, ft | | | | | | | |
| | 0.25 | 0.75 | 1.25 | 1.75 | 2.25 | 2.75 | 3.25 | 3.75 |
| 0.00 | 191.0[2] | BI[3] | BI | BI | BI | BI | BI | BI |
| 4.00 | 72.00 | 190.00 | BI | BI | BI | BI | BI | BI |
| 6.00 | 46.00 | 94.00 | 96.00 | BI | BI | BI | BI | BI |
| 8.00 | 38.00 | 58.00 | 82.00 | 80.00 | BI | BI | BI | BI |
| 12.00 | 52.00 | 72.00 | 66.00 | 62.00 | – | – | BI | BI |
| 24.00 | – | 29.00 | 53.00 | 42.00 | – | – | – | BI |
| 48.00 | – | 32.00 | 24.00 | 46.00 | – | – | – | BI |
| 96.00 | – | – | – | – | 18.00 | 38.00 | – | 54.00 |
| 168.00 | – | 15.00 | 12.00 | 32.00 | – | 22.00 | 34.00 | 42.00 |
| 264.00 | – | – | 16.00 | 10.00 | 14.00 | 14.00 | 20.00 | 12.00 |
| 360.00 | – | – | 18.00 | 14.00 | 18.00 | 26.00 | 20.00 | 22.00 |

[1]The slurry concentration was 83.95 g/L.
[2]Concentration at highest port used as initial supernatant concentration.
[3]Port is below interface, and no sample was collected at this time interval.

| Table A15<br>Composite Sediment Flocculent Settling Test Data for Reach 2[1] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Time hr | Depth from Top of Settling Column, ft | | | | | | | |
| | 0.23 | 0.73 | 1.23 | 1.73 | 2.23 | 2.73 | 3.23 | 3.73 |
| 0.00 | 406.00 | BI | BI | BI | BI | BI | BI | BI |
| 4.00 | 228.00 | 310.00 | BI | BI | BI | BI | BI | BI |
| 6.00 | 138.00 | 236.00 | BI | BI | BI | BI | BI | BI |
| 8.00 | 126.00 | 202.00 | 302.00 | BI | BI | BI | BI | BI |
| 12.00 | 80.00 | 138.00 | 202.00 | 222.00 | BI | BI | BI | BI |
| 24.00 | 46.80 | 98.00 | 127.00 | 97.80 | BI | BI | BI | BI |
| 48.00 | – | 60.00 | 50.00 | BI | BI | – | BI | BI |
| 96.00 | – | 44.00 | 34.00 | 20.00 | – | – | 102.00 | BI |
| 168.00 | – | 31.00 | 24.00 | 32.00 | – | – | 78.00 | – |
| 264.00 | – | 11.00 | 6.00 | 14.00 | 12.00 | 12.00 | 6.00 | 14.00 |

[1]The slurry concentration was 90.19 g/L.
[2]Concentration at highest port used as initial supernatant concentration.
[3]Port is below interface, and no sample was collected at this time interval.

**Table A16**
**Composite Sediment Flocculent Settling Test Data for Reach 3**[1]

| Time hr | Depth from Top of Settling Column, ft | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.29 | 0.79 | 1.29 | 1.79 | 2.29 | 2.79 | 3.29 | 3.79 |
| 0.00 | 260.00[2] | BI[3] | BI | BI | BI | BI | BI | BI |
| 6.00 | 104.00 | 122.00 | BI | BI | BI | BI | BI | BI |
| 8.00 | 100.00 | 86.00 | BI | BI | BI | BI | BI | BI |
| 12.00 | 58.00 | 64.00 | BI | BI | BI | BI | BI | BI |
| 24.00 | 36.70 | 47.90 | 63.80 | – | – | – | BI | BI |
| 48.00 | 56.00 | 32.00 | 66.00 | 76.00 | – | – | BI | BI |
| 96.00 | – | 14.00 | 13.00 | 20.00 | 26.00 | – | 114.00 | BI |
| 168.00 | – | 30.00 | 22.00 | 36.00 | 52.00 | 68.00 | 108.00 | BI |
| 264.00 | – | 10.00 | 10.00 | 8.00 | 4.00 | 10.00 | 12.00 | 44.00 |
| 360.00 | – | – | – | 18.00 | 18.00 | 21.00 | – | 72.00 |

1 The slurry concentration was 105.19 g/L.
2 Concentration at highest port used as initial supernatant concentration.
3 Port is below interface, and no sample was collected at this time interval.

**Table A17**
**Calcasieu River Sediment Physical Characteristics**

| | | | Atterburg Limits | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample No. | Water Content | Specific Gravity | LL | PL | PI | Symbol | Sand % | Silt % | Clay % |
| CR-1(Mi 36.0) | 55.2 | 2.68 | 51 | 19 | 32 | CH2 | 23.6 | 34.5 | 41.9 |
| CR-2(Mi 35.5) | 46.0 | 2.60 | *- | - | - | - | 63.8 | 26.5 | 9.7 |
| CR-3(Mi 35.0) | 68.0 | 2.56 | *- | - | - | - | 44.0 | 49.3 | 6.7 |
| CR-4(Mi 34.5) | 53.0 | 2.64 | 34 | 23 | 11 | CL-4 | 45.2 | 39.6 | 15.2 |
| CR-5(Mi 34.0) | 59.0 | 2.61 | 41 | 21 | 16 | CL-4 | 57.8 | 29.9 | 12.3 |
| CR-6(Mi 33.5) | 114.0 | 2.50 | 137 | 36 | 101 | - | 62.0 | 32.6 | 5.4 |
| CR-7(Mi 33.0) | 176.4 | 2.38 | 154 | 52 | 102 | - | 4.0 | 61.2 | 34.8 |
| CR-8(Mi 32.5) | 46.0 | 2.61 | *- | - | - | - | 45.2 | 44.2 | 10.6 |
| CR-10(Mi 31.5) | 78.0 | 2.60 | 275 | 58 | 217 | CHOC | 56.8 | 35.7 | 7.5 |
| CR-11(B.D'Inde) | 382.0 | 2.13 | 334 | 92 | 242 | CHOC | 41.8 | (58.2) | - |
| CR-12(Mi 31.0) | 228.0 | 2.15 | 83 | 31 | 52 | CH-4 | 85.6 | (14.4) | - |
| CR-13(Mi 30.5) | 429.0 | 2.16 | 311 | 130 | 181 | CHOC | 52.0 | (48.0) | - |
| CR-14(Mi 30.0) | 34.2 | 2.66 | 40 | 14 | 26 | CL-6 | 9.2 | 54.1 | 36.7 |
| CR-15(Mi 29.5) | 65.0 | 2.59 | *- | - | - | - | 64.2 | 29.0 | 6.8 |
| CR-16(Mi 29.0) | 282.0 | 2.29 | 148 | 57 | 91 | CH-OA | 72.2 | 25.1 | 2.7 |
| CR-17(Mi 28.5) | 120.2 | 2.52 | 92 | 37 | 55 | CH-4 | 51.0 | 40.3 | 8.7 |
| CR-18(Mi 28.0) | 130.2 | 2.52 | 104 | 32 | 72 | CH-4 | 43.0 | 41.9 | 15.1 |
| CR-19(Mi 27.5) | 127.0 | 2.48 | 116 | 38 | 78 | CH-OA | 65.4 | 25.0 | 9.6 |
| CR-20(Mi 27.0) | 70.1 | 2.55 | *- | - | - | - | 49.4 | 37.1 | 13.5 |
| CR-21(Mi 26.5) | 51.0 | 2.64 | *- | - | - | - | 61.8 | 28.4 | 9.8 |
| CR-24(Mi 25.0) | 114.5 | 2.64 | 86 | 35 | 51 | CH-4 | 18.4 | 46.9 | 34.7 |
| CR-25(Mi 24.5) | 74.0 | 2.60 | 71 | 24 | 47 | CH-4 | 28.0 | 43.5 | 28.5 |
| CR-26(Mi 24.0) | 135.0 | 2.63 | 104 | 23 | 81 | CH-OA | 18.0 | 57.5 | 24.5 |
| CR-27(Mi 23.5) | 97.0 | 2.69 | 59 | 19 | 40 | CH-3 | 17.2 | 69.3 | 13.5 |
| CR-28(Mi 23.0) | 101.3 | 2.71 | 68 | 21 | 47 | CH-3 | 57.0 | 35.9 | 7.1 |
| CR-29(CLIS,S) | 96.1 | 2.59 | 61 | 25 | 36 | CH-3 | 35.4 | 57.5 | 7.1 |
| CR-30(CLIS,M) | 193.2 | 2.61 | 83 | 29 | 54 | CH-4 | 63.0 | 31.1 | 5.9 |

Note:
CR-1 through CR-7, CR-29, CR-30 were composited as Reach 1.
CR-8 and CR-10 through CR-14 were composited as Reach 2.
CR-15 through CR-21 and CR-24 through CR-28 were composited as Reach 3.
( ) - means silt and clay combined.
*- - Sample has too much silt to obtain Atterburg.
B.D'Inde - Calcasieu River at confluence with Bayou D'Inde.
CLIS,S - Clooney Island Loop (south end).
CLIS,M - Clooney Island Loop (middle).

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**13. ABSTRACT** *(Maximum 200 words)*

The periodic maintenance of 14 miles of the Calcasieu River by sediment removal is required to restore a navigable waterway. One alternative being considered for the Calcasieu River is hydraulic dredging, with temporary or permanent dredged material disposal in an upland confined disposal facility (CDF).

Monitoring data collected during the 1988-1989 maintenance event indicated that the CDFs may not have been properly managed for maximum efficiency in settling, retention of suspended solids, and possible contaminants.

Laboratory column settling tests and modified elutriate tests were performed on three Calcasieu River sediments. The settling behaviors were observed to be typical of other sediments if hydraulically dredged and placed in a CDF. The compression tests data were used to develop the initial storage requirements. The flocculent tests data indicated that the suspended solids will settle by gravity. Results of the modified elutriate tests, which predict both dissolved concentrations of contaminants and particle-associated contaminant under quiescent settling conditions, were below the Federal Water Quality Criteria.

**14. SUBJECT TERMS**

| | | |
|---|---|---|
| Compression | Modified elutriate | Turbidity |
| Confined disposal facility | Sedimentation | |
| Flocculent | Suspended solids | |

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